

XI. *The comparative anatomy of the male genital tube in Coleoptera.* By D. SHARP, M.A., F.R.S., and F. MUIR, F.E.S.

[Read February 7th, 1912.]

PLATES XLII-LXXVIII.

ARRANGEMENT OF MEMOIR.

- I. INTRODUCTORY.
- II. ORISMOLOGY AND TECHNIQUE.
- III. MORPHOLOGY.
 - A. ANATOMY.
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I. INTRODUCTORY.

THE object of this memoir is to review the structure of the male genital tube throughout the Order Coleoptera. This is not equivalent to a review of the male copulatory organs. The modifications of the abdomen itself are extremely extensive and varied, but we have perforce omitted them, because the time at our disposal was scarcely adequate for the accomplishment of the work, the results of which are here presented.

Mr. F. Muir, having returned to England for a year's vacation in order to recruit his health after a long period of arduous entomological work in the tropics, joined the senior author at Brockenhurst, and the two combined their efforts for the production of this memoir.

A work of the kind is almost indispensable in the present state of Coleopterology, and the authors hope that it will be received as a much needed contribution to a great subject. A subject too as to which, notwithstanding its slight advancement, great misconception is prevalent.

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The work has nearly all been carried out in the little laboratory attached to the residence of the senior author at Brockenhurst, and in a period of little more than twelve months. Each of the authors has devoted some independent work to it since Mr. Muir's departure for Honolulu, and it is hoped that this fact will be accepted as some excuse for certain inconsistencies that may be discovered by a severe critic.

The drawings that form so important a part of the work have all been made by the junior author, and consequently on him has fallen the difficult task of deciding as to the ventral and dorsal aspects of the structures. This is far from easy; it is, in fact, beset with sources of deception, as may be seen from the note (as to a discovery made by the junior author) placed in front of our descriptions of the family *Scarabacidae*.

A primary object of the authors being to make a review extending over all the Order, they could only hope, in the too short time at their disposal, to get together the necessary material by the aid of their friends. Appeals were therefore issued with this object, and met with the most obliging responses; and we naturally desire to tender our warmest thanks to all those who have helped us in this and in other ways. We must mention first of all Mr. G. J. Arrow of the British Museum of Natural History; the only limit to whose kindness has been the reluctance we felt as to taking his attention from more important duties.

Mr. Antwerp E. Pratt made over to us a considerable collection of Coleoptera from New Guinea. This enabled us to examine a number of specimens in the case of certain species, and has been most useful, though, for our purpose, it has been subject to the drawback of several of the forms being new or little-known species.

Mr. J. C. Moulton of Sarawak, Mr. T. Bainbrigge Fletcher of Pusa, Mr. Arthur M. Lea of Tasmania, Mr. W. W. Froggatt of Sydney, sent us useful material. Herr Edmund Reitter of Paskau was so good as to select from his stores and send to us several forms we specially needed. In our own country Commander Walker and Mr. G. A. K. Marshall provided important material. Mr. Geo. Lewis has given us a few interesting forms. Mr. Ford of Bournemouth, and Mr. Janson of London gave themselves considerable trouble in the selection of speci-

mens for us. Mr. Hugh Scott of Cambridge University assisted us in every way that we asked.

Mr. G. C. Champion and Mr. C. J. Gahan have been very good by helping us in the disagreeable task of naming our heterogeneous material.

As regards the taxonomical and phylogenetic portions of the memoir it is desirable that we should say that they are drawn up to display the part that a knowledge of the fertilising structures should have in these two departments of Coleopterology. The senior author has for many years taken an interest in the taxonomy and phylogeny of *Coleoptera*, and it would therefore be absurd to pretend that, apart from consideration as to the sexual organs, he is in complete ignorance as to the bearings of other branches of anatomy, of physiology, of ethology and of ontogeny on the two departments mentioned. But the junior author is comparatively a recent student of these departments; and the senior author, therefore, gave him a free hand in drawing up the tables, and has modified them but little. They represent, therefore, fairly well the results that may be obtained in taxonomy and phylogeny from a preliminary study of the male genital tube. We hope that we have made it clear, in other parts of the paper, that our work is only a very imperfect introduction to this comparatively narrow field of inquiry. But we believe the subject will prove to be of great importance when combined with the results derived through other lines of investigation. There is one point, however, in the memoir that has not been based on study of the aedeagus, viz. the families we have made use of. Though we shall have in the course of this memoir to propose several changes as to the families of *Coleoptera*, it must not be supposed that the families here dealt with have been decided on from the point of view of the structure of the genital tube. The forms studied were selected in the first instance simply by our desire to study these structures throughout the whole Order. We may, however, say that though certain changes will have to be made, yet our impression is that most of the families at present in use in Coleopterology will have their validity substantiated by a continuance of this study.

The second part of our morphological section deals with the nature of the male organs; and under the heading *Phytophagoidea* in the section phylogeny some more

speculative opinions on the same subject are given; but a brief elementary statement on this point will probably be found useful here. Two simple diagrams (figs. 239 and 239a) have been made with the same object. They are really diagrammatic and do not represent any particular form.

Let a glove be taken, a hole pierced in the tip of one of its fingers, a slender tube attached around this hole, this tube being placed inside the finger and prolonged into the hand-part of the glove: and we have before us a rough model of the genital tube.

This structure lends itself to modification in the readiest manner. By traction on the slender tube the finger of the glove can be entirely drawn into the hand, with the result that the distal orifice becomes proximal. Let the glove finger be restored to its natural position and some hard patches be put on it, and the operation of invagination be again repeated, and it will be noted how protean this simple arrangement can become. Further make some small folds on the finger, and suppose these to grow out (after the fashion of the horns and processes on the heads of Lamellicorn beetles) and the reader will then have a general idea of the structures we are about to consider.

The finger of the glove can be made by some folds to collapse in several layers, like a shut-up nautical telescope, and this telescopic arrangement can be carried to such an extent that Straus-Durckheim (*Melolontha vulgaris*, pl. vi, f. 1) shows in a section of the telescopically collapsed tube no less than eleven superposed layers.

We scarcely need to remark that the retraction and eversion of the genital tube are not brought about by force applied to the duct.

We have had considerable difficulty in arranging our matter in a comprehensible sequence, and the different sections of the memoir are not conformable in this respect. We have endeavoured to diminish the inconvenience resulting from this by means of an alphabetical index of the names of families and groups placed immediately before the explanation of the figures.

In the course of this memoir we have occasion to refer the reader to a passage of the historian Gibbon, relating to the Empress Theodora, the consort of the Emperor who rebuilt the great cathedral of Saint Sophia at Constantinople. We may fittingly close our introductory

remarks by a quotation from the same chapter of this immortal author. He says, "A magnificent temple is a laudable monument of national taste and religion, and the enthusiast who entered the dome of St. Sophia might be tempted to suppose that it was the residence, or even the workmanship of the Deity. Yet how dull is the artifice, how insignificant is the labour, if it be compared with the formation of the vilest insect that crawls upon the surface of the temple!"—Gibbon, "Decline and Fall of the Roman Empire," chap. xl.

II. ORISMOLOGY AND TECHNIQUE.

The following is a list of some of the terms we have applied to parts of the male genital tube, and we add a few synonyms used by other writers. The letters in brackets are those made use of in the plates.

This section is concluded by some critical remarks.

AEDEAGUS. The median lobe and tegmen together. It is the Edeagophore of Blaisdell.

AZYGOS, or the azygotic portion of the male genital tube. It comprises all the unpaired portion of the tube from the body wall to the divergence of the seminal ducts, where the zygotic portion, or efferent ducts, ends (*b-d* and 5-1, fig. 239).

BASAL-PIECE (*bp*). The basal part of the tegmen. It is the "basale" (Blaisdell); external lobes (Packard); basalplatte (Verhoeff); tambour (Straus-Durckheim).

EJACULATORY DUCT (*ej*) or stenazygos is the slender portion of the genital tube from the seminal ducts to the internal sac or eurazygos.

EURAZYGOS (*e-d* and 5-1, fig. 239). The enlarged portion of the genital tube.

FIRST CONNECTING MEMBRANE (*cm1*). The membrane connecting the median lobe to the tegmen.

INTERNAL SAC (*is*). The enlarged portion of the azygos which is more or less evaginated during copulation. It is the sac interne (Jeannel); praeputialsack (Verhoeff), and forms part of the ejaculatory duct of most writers.

LATERAL LOBES (*ll*). The distal portion of the tegmen. In the generalised trilobe type they form two free processes lateral of the median lobe and often en-

veloping it. They are the "deux branches de la pince" (Straus-Durckheim); mesostili in *Procrustes*, ipofallo in *Lucanus* and perifallo in *Dytiscus* (Berlese); apicale (Blaisdell), lateral lobes (Packard), Parameren (Verhoeff).

MEDIAN FORAMEN (*mf*). The aperture, or lumen, at the base of the median lobe through which the ejaculatory duct passes.

MEDIAN LOBE (*ml*). The central portion of the aedeagus upon which the median orifice is situate. It is the penis of Straus-Durckheim, Verhoeff, Packard and many other writers, Körper (Lindemann), body (Hopkins), ipofallo in *Procrustes* etc., and penis in *Oryctes* (Berlese).

MEDIAN ORIFICE (*mo*). The opening, or area, on the median lobe through which the internal sac is evaginated. It is the "Mundung ductus ejaculatorius" (Verhoeff), fornix edeagi (Blaisdell) and apical opening (Hopkins).

MEDIAN STRUT (*ms*). A single strut, or a pair of struts, proceeding from the basal part of the median lobe. In some cases they are articulated to the median lobe, in other cases they actually form part of the median lobe without articulation or line of demarcation.

POINT OF ARTICULATION (*pu*). The point on the median lobe to which the lateral lobes are attached. In many cases the median lobe and tegmen are connected by intervening membrane and there is no point of articulation.

SECOND CONNECTING MEMBRANE (*cm2*). The membrane connecting the tegmen to the termination of the abdomen. It is the prepuce of Straus-Durckheim (*Melolontha vulgaris*).

SPICULE (*sp* fig. 224*a*). A sclerite attached by one end to the second connecting membrane. In many cases it is Y- or T-shaped. It is the Stengel (Lindemann), spiculum gastrale (Verhoeff), rod or fork (Hopkins), and is considered by some as being the last sternite. It is not infrequently similar in shape to another sclerite that pertains to another layer of the genital tube.

STENAZYGOS. Is the stenazygotie or slender portion of the azygos (*b-c*, fig. 239).

TEGMEN (*tg*). The term applied to the lateral lobes and

basal-piece together. It is the ring (Hopkins), Gabel (Lindemann).

VENTRAL PLATE (*vp*, fig. 19, etc.). A sclerite on the anterior ventral surface of the basal-piece in some Lamellicorns. In some cases the lateral lobes are consolidated to its anterior edge. The chitinisation of this part varies much.

ZYGOS. Zygotic portion of the male genital tube; and is formed by the two seminal ducts (*a-b*, fig. 239) proceeding from the testes.

METHOD EMPLOYED.

In preparing this memoir it was necessary to make use of a great deal of dried material, some of it fifty and sixty years old, as our time was limited and we could not procure fresher specimens. In such cases we found the following methods acted very well and, if care was used, did not destroy the specimen. The dried specimens were placed in water and allowed to soak for a time according to the size and condition of the specimen, the water being heated if necessary; when thoroughly relaxed the aedeagus was dissected out, either through the opening between the last dorsal and ventral plates, or the last segment was taken off, or the abdomen was taken off at the base, the aedeagus extracted through the basal foramen and, when necessary, the abdomen stuck on to the thorax again. The aedeagus was then placed in weak caustic potash for a time when the muscles would swell up and could then be dissected; in cases where it was necessary to clear off all the muscles the caustic potash was used very strong. To get the internal sac evaginated was a more difficult matter; but with care it was possible to do this by the use of localised pressure, and with the aid of a very finely pointed syringe. By inserting the fine point into the median foramen and gently applying pressure the internal sac can be forced out in a manner, if not quite natural at least near enough to study its shape and structure.

With fresh material it was a much easier matter, especially with bulbous forms such as are found among the Staphylinidae; by placing the aedeagus in water and gently pressing upon the bulb the internal sac can be made to evaginate in a perfectly natural manner.

To study the position taken up by the internal sac

within the uterus during copulation it was necessary to take the beetles in copula, kill them in a strong killing-bottle and then dissect out the whole female organ with the internal sac of the male still in situ.

We may here emphasise the great importance of extracting the structures without injury to the basal parts. It is necessary to give this caution because it too often happens that the dissections of these parts that exist in various collections have been made only with a view to examining the apical portions of the structures. Hence the basal parts are often found to have suffered serious injury.

As there can be no doubt that the nature of the genitalia is destined to play a prominent part in the systematic study of Entomology, the terms to be used in it should be carefully considered. At present great confusion prevails. This is not a matter for surprise when the difficulties that exist are grasped. The male structures form parts and accessories of a genital conduit of which the female genitalia are the continuation and completion. Hence the male parts are really only comprehensible when studied in connection with the female parts; and this, moreover, when the two are functioning. The parts, in fact, have to be restored to the condition they are in during copula.

The terms used in this memoir were of necessity selected soon after the commencement of our work, and we consider it advisable here to state how they appear to us at the conclusion of our undertaking.

AEDEAGUS. This is a most convenient and useful term for the combination of sclerites in the two adjacent layers of the male tube. The term was, we believe, introduced by M. A. C. M. E. Foudras (Altisides, 1859, p. 32). It is probably derived from the Greek *τὰ αἰδοῖα*, signifying the genitals. The use of the Greek word may be seen in the notorious passage of Procopius quoted by Gibbon in footnote 24 of chap. xl of "The Decline and Fall." We doubt whether a better term could be found for this middle complex of male sclerites, and we expect that a word will have to be invented for the corresponding (if not homologous) female sclerites.

MEDIAN LOBE. This term is not free from serious objections, but it is far superior to that of "penis," which applied to Insecta is totally fallacious. The part in

Insecta that most nearly approximates to the Vertebrate penis is the internal sac, the knowledge of which has been almost nothing until its recent inauguration by Jeannel. The median lobe appears to be sometimes a complex or amalgamation of more or less individualised sclerites. (Cf. *Hydrophilus*.)

LATERAL LOBES. Though a very suitable term for the parts in the various trilobe forms, it is inappropriate in cases where the projections (if homologous at all) are medianly situate. Paramere is quite as good as lateral lobes. Cornua (meaning cornua tegminis) is also not free from objection, and accessory process is rather cumbersome. Tegminal lobes might do if the term tegmen be itself accepted.

BASAL-PIECE. Perhaps this term may stand till more is known about the cases in which it is two pieces, and those in which it appears to be absent.

INTERNAL SAC. Probably the term Vesica might be preferable. But this part of the conduit is so protean in form and development that it might be better to invent a term indicating a structure that is predominantly membranous.

TEGMEN. This term seems convenient and adequate for the layer of sclerites external to the median lobe. The elytra of grasshoppers are frequently called tegmina, but we do not think this objection to our use of the term a serious one.

CONNECTING MEMBRANES. This term cannot be commended. It gives the idea that the sclerites are the important structures. But the tube may exist without sclerites and is it then a connecting membrane?

Other terms (such as Prepuce) that have been used for various parts are totally unsuitable. We consider that it is premature to endeavour to establish permanent terms for the parts of the complex genitalia of Insects till the various Orders have been more thoroughly examined and compared.

III. MORPHOLOGY.

A. SPECIAL ANATOMY.

Family CICINDELIDAE.

Forms examined: *Manticora tuberculata* Deg., S. Africa. *Omus californicus* Esch., N. America. *Cicindela tortuosa* Dej., N. America. *Therates labiatus* Fabr., New Guinea. *Tricondyla aptera* Ol., New Guinea.

Figs. 29–31 of Pl. XLVII.

Manticora tuberculata (Pl. XLVII figs. 31, 31a, 31b).

Median lobe curved, tubular; median orifice at distal end on ventral side, about one-fifth the length of lobe; median foramen at basal end, as large as circumference of lobe; dorsal edge forming a projection to which lateral lobes are articulated. Lateral lobes broad at base, with slender, free tips. Basal-piece shield-shape, connected to lateral lobes by a curved band broader in middle; the lateral lobes are slightly asymmetrical and the distal end of each lobe lies on the left side of the median lobe. The internal sac is nearly as long as the median lobe; at the point where the ejaculatory duct enters the sac there is a small chamber with chitinous walls (fig. 31b) drawn out into a long, slender flagellum, with the external opening at its tip. Only the baso-dorsal part of the sac is evaginated, as a tongue, with the lateral edges turned down to form a groove, along which the flagellum passes (fig. 31a); the rest of the sac is crushed up like a concertina and the flagellum is pushed out.

Omus californicus.

Median lobe as in *Cicindela* but irregular in outline; basal half of lateral lobes wider than in *Cicindela*, distal half tapering to a point. Basal-piece forming a thin V-piece on ventral side of median lobe. Internal sac well developed, a thin, long, curved chitinous spine rising from the apex.

Cicindela tortuosa (Pl. XLVII fig. 30).

Median lobe curved, tubular, swollen along the distal two-thirds; median orifice forming a slit along ventral side of the distal fourth of lobe; median foramen at basal end. Lateral lobes slender, two-thirds as long as median lobe. Basal-piece V-shaped, connected to lateral lobes about one-third from their base. Internal sac large,

and, when invaginated, coiled up, with a long, slender flagellum arising from apex with external opening of duct at tip (not shown in figure).

Therates labiatus (Pl. XLVII fig. 29).

Median lobe tubular, curved, thick, smaller and slightly flattened perpendicularly at base, median orifice at distal end, median foramen at basal end. Tegmen consisting of a pair of thin symmetrical lateral lobes, reaching to near tip of median lobe, and a wide V-shape basal-piece. Internal sac large with chitinous plates and two chitinous spines on sac, one curved and thin, the other short, thick and straight; the duct enters at apex but not through spine (i. e. the spine is not of the nature of a flagellum).

Tricondyla aptera.

Median lobe curved, and tubular as in *Manticora*. The tegmen consisting of slender lateral arms and V-shaped basal-piece, as in *C. tortuosa*. Internal sac median size with large diverticula near apex and a large, strong bent spine on sac which is not traversed by the duct, the duct opening on apex of a small membranous tongue at the tip of the sac.

Obs.—The Cicindelid *aedeagus* is similar to that of *Carabidae* in structure; but is distinguished from all the Carabid types we are acquainted with by the presence of a basal-piece in the form of a sclerite on the ventral side of the median lobe. In this respect they resemble other Coleoptera more than the Carabidae do; but in the development of the internal sac with spines and a long flagellum they are more highly specialised. A great number of the Carabids are asymmetrical, whilst the Cicindelids are generally symmetrical or nearly so. The diagnostic of the family is the same as that of the other families of the Caraboid series, except as regards the basal sclerite, which appears to be various in the series.

Family CARABIDAE.

Forms examined: *Carabus violaceus* L., Brockenhurst. *Cychrus ventricosus* (teste Leconte), California. *Metrius contractus* Esch., California. *Blethisa multipunctata* L., England. *Nebria brevicollis* Fabr., Brockenhurst. *Mormolyce phyllodes* Hag., loc.? *Pheropsophus agnatus* Chd., China. *Clivina fossor* L., Brockenhurst. *Anthia sexgut-*

tata Fabr., India. *Tefflus difficilis* Sternberg, Nyasaland. *Pterostichus niger* Sch., and *oblongopunctatus* Fabr., Brockenhurst. *Ophonus sabulicola* Panz., Southsea. *Laemosthenes complanatus* Dej., Southsea. *Bembidium biguttatum* Fabr., Brockenhurst.

Figs. 32-35 of Pls. XLVII and XLVIII relate to Carabidae.

Carabus violaceus (Pl. XLVII figs. 32 and 32a).

Median lobe long, tubular and well chitinised; median orifice extending about one-third along ventral side, the chitin of lobe thinning out into membrane of sac; median foramen running across basal end of lobe, the edge of which projects on dorsal side for attachment of lateral lobes. Lateral lobes thin, especially at distal end, nearly reaching to tip of median lobe. Internal sac well developed, covered with short dark spines on basal half; folds of membrane around opening of duct (*od*) complex (Fig. 32a). The figure shows a depression along the dorsal side which under fluid pressure becomes everted.

Cychrus ventricosus.

Somewhat like *C. violaceus* but median lobe more curved, especially at base. Lateral lobes stouter and developed more perfectly, with tips slender and bearing a few hairs. Internal sac short (about one-third the length of median lobe) with long thread-like diverticula immediately ventral of opening of duct; surface of sac studded with minute papillae.

Nebria brevicollis (Pl. XLVII fig. 34).

Median lobe curved cone-shape, the median orifice being situated at the small distal end, the median foramen at the large basal end. Lateral lobes attached to dorsal edge of median foramen, left lobe broad, flat, reaching to tip of median lobe, right lobe broad and flat, reaching about two-thirds along median lobe. Internal sac small and undifferentiated.

Metrius contractus

Median lobe short, deep, flattened; the distal end produced into a curved blunt spine; median orifice narrow, running along one-fourth of ventral side of lobe, near distal end; median foramen on basal end somewhat dorsal. Left lateral lobe narrow, spatulate at end, with fringe of long hairs along dorsal side, a little longer than median lobe; right lobe shorter, broader and produced to point, without hairs along edge. Internal sac large and complex.

Blethisa multipunctata.

The aedeagus of this species is remarkable by the small area of the median lobe that is chitinised, the larger part of the lobe being membranous. This species has also a very peculiar feature, inasmuch as a long strut extends forwards. This strut appears to be a process of the internal sac, and has nothing in common with the strut of Dytiscidae that at first sight appears to be similarly placed. It is unfortunately too late to add a drawing of this interesting structure to our plates.

Mormolyce phyllodes (Pl. XLVII figs. 33 and 33a).

Median lobe very short, stout, and funnel shaped ; median orifice large, across distal end, the edge of left side being drawn out into a narrow tongue ; median foramen large, across base of lobe, with lateral lobes attached to edge on dorsal side. Left lateral lobe small and flattened, right lobe double the size of left. Internal sac when evaginated twice as long as median lobe, with blunt short diverticula near apex and the apical part granulated. It is possible that the sac as figured is not entirely evaginated near apex.

In this paradoxical insect, the articulation between the lateral lobes and the median seems to be imperfect, but our preparation is from an immature example.

Pheropsophus agnatus (Pl. XLVIII fig. 35).

Median lobe short, pointed ; median orifice occupying median portion on ventral side of lobe ; median foramen basal. Lateral lobes small, irregular and sub-equal. Internal sac large, with blunt, short diverticula near base and on ventral side.

Anthia sexguttata.

Median lobe forming an irregular tube, abruptly bent up dorsally near base ; median orifice a narrow slip along one-fourth of tube on ventral side near apex, continuing as a depression to near bend at base ; median foramen at basal end. Lateral lobes small, thick and irregular, right larger than left.

Tefflus difficilis.

Very solid tubular median lobe, somewhat asymmetrical, with short thick lateral lobes attached to its dorsal basal point, the right lateral lobe larger than the left ; median orifice at distal end, median foramen at basal end, slightly dorsal. Internal sac large, complex, covered with chitinous granulations.

The Carabid aedeagus consists of a more or less asymmetrical median lobe, with small but very varied lateral lobes attached to the dorsal side of the base of the median lobe, often very asymmetrical and often very much reduced. The basal piece absent, or rather not to be distinguished from the second connecting membrane. Internal sac often complex and well developed, contained in median lobe when invaginated (not passing through median foramen). When withdrawn into abdomen the aedeagus lies on its side.

The absence of a basal sclerite separates this family from the Cicindelidae.

Family PAUSSIDAE.

The form examined appears to be the S. African *Orthopterus smithi* Macl. Our specimen has no locality label.

Fig. 41 Pl. XLIX.

Orthopterus smithi (Pl. XLIX fig. 41).

Median lobe a chitinous curved tube, thinner at distal end than at base; median foramen as large as the lobe, with the lateral lobes attached to its dorsal edge; median orifice formed by an asymmetrical slit at distal end, the right edge being produced into a small curved knob, the left into a curved flattened point. Right lateral lobe broad, and flattened, reaching to near apex of median lobe, left lateral lobe narrow and slightly shorter; a small thin sclerite is attached to connecting membrane between the lateral lobes on ventral side (not shown in figure) and appears to be homologous to the basal-piece in *Dytiscus*. Internal sac fairly large and when evaginated funnel shape.

This aedeagus is distinctly Caraboid and strongly reminds one of *Nebria*. If we may judge from a single dissection the family differs from Carabidae by the possession of a scleritic basal-piece.

Family RHYSODIDAE.

Form examined is a species from Queensland, not contained in the British Museum Collection. It is a large form somewhat resembling the European *R. sulcatus*.

Fig. 36 Pl. XLVIII.

Rhysodes sp. ? (Fig. 36).

Median lobe a strongly chitinised, curved tube, with median orifice on ventral side of apex and median foramen at basal end. Lateral lobes asymmetrical, the right large, flat and subtriangular, the left small and irregularly oval. Internal sac well developed, a large lobe arising from the apex armed with patches of hairs and chitin plates.

This is a characteristic Caraboid type and must be placed near that family.

Family PELOBIIDAE.

Pelobius tardus Herbst, from Brockenhurst has been examined.

Fig. 40 Pl. XLIX.

Pelobius tardus (Pl. XLIX fig. 40).

Median lobe strong, curved, somewhat flattened, produced into blunt barb at tip, with a shallow groove along the ventral side (or the lateral edges turned down ventrally), a membranous tongue (*a*) covers the basal four-fifths of the groove, the median orifice being covered by this tongue. Lateral lobes large, produced into filament at apex; articulated to median lobe on dorsal side of base. Basal-piece forming a T-shape sclerite, with a large head. No differentiated sac.

Family HALIPLIDAE.

The form examined is the common European *H. fulvus* Fabr.

Fig. 39 Pl. XLVIII.

Haliplus fulvus (Pl. XLVIII fig. 39).

Median lobe a flattened curved body, deeply grooved along the ventral side, with a membranous tongue (*a*) covering the basal three-fourths of groove; the basal part expanded, with lateral lobes articulated to dorsal edge. Lateral lobes asymmetrical, left one short and broad, with hairs on inner surface near distal end; right lobe longer and narrower, with slender tip, inner surface covered with long fine hairs. Basal-piece forming a wide V-shape sclerite joining lateral lobes across the ventral side. No differentiated sac.

Family DYTISCIDAE.

Forms examined: *Dytiscus punctulatus* Fabr., and *D. marginalis* L., England. *Ilybius aenesccens* Th., England. Figs. 37 and 38 Pl. XLVIII.

Dytiscus punctulatus (Pl. XLVIII figs. 37 and 37a).

Basal half of median lobe forms a tube, the distal half projecting as four prongs, the dorsal one chitinous, the ventral and lateral ones membranous (fig. 37a, a. b. b.). The dorsal half of lobe forming a strong chitinous plate, broader and turned down in the middle (c) and bearing hairs at the apex, the basal part being curved upward and expanded; the ventral half is membranous (m). Lateral lobes large and broad, bearing hairs at the tip and attached to the base of the median lobe on the dorsal side (pa). A thin strut (bp) broad at the end where it supports the membrane between the bases of the lateral lobe, on the ventral side, represents the basal-piece. This functions as a lever to which the muscles for turning the aedeagus are attached. When invaginated the aedeagus rests on its side, but when evaginated it takes a turn and the dorsal becomes ventral. Our figure shows it in its true dorso-ventral position. Sac undifferentiated.

Dytiscus marginalis.

This only differs in details from *D. punctulatus*, the median lobe is expanded into a small flattened disc at apex; the lateral lobes are longer.

Ilybius aenesccens (Pl. XLVIII fig. 38).

Median lobe consisting of a strong, curved, thin sclerite, broadened at the base and turned down to form a short groove, the ventral side of this groove being covered by a membranous tongue (a), thus forming a very short tube where the undifferentiated sac opens. Lateral lobes broad at base, flattened and slightly twisted at tips and attached on dorsal side of the base; the inner dorsal surface being studded with short stout sense-hairs, the rest of inner surface with long fine hairs. Basal-piece (bp) broad at the end where it partly surrounds the base of the median lobe but narrow beyond.

This appears to be a more perfect structure than the aedeagus of *Dytiscus*.

The three families, Dytiscidae, Haliplidae, and Peliobiidae, are closely allied as to the aedeagus, the median lobe being on the same plan, and differing from Carabidae

and Cicindelidae. In the latter two families the median lobe is a more or less perfect tube with the median orifice at or near the distal end, and the median foramen at the basal end; in the three other families it forms a chitinous organ, grooved along the ventral surface (or the lateral margin turned down), with a membranous tongue covering the basal part of the groove. There being no differentiated sac it is impossible to say how much of the ejaculatory duct is evaginated during coition.*

Unfortunately the only Amphizoidae we could procure were females.

Family GYRINIDAE.

Forms examined: *Enhydrus* sp. n., aff. *E. atrati*, Lita, 4000 ft. *Gyrinus natator* and *urinator*, England. *Orectochilus dispar* Walker, Ceylon.

Figs. 42, 43 and 43a Pl. XLIX.

Gyrinus natator (Pl. XLIX fig. 42).

Median lobe slightly flattened and curved; tip truncate; dorsal and lateral parts chitinous; median orifice forming a narrow slit on the membranous ventral side near tip; median foramen at base. Lateral lobes flattened horizontally, narrow at base and gradually widening to truncate apex, which bears long hairs; consolidated along ventral basal half and near base on dorsal side. Median lobe articulated to base of lateral lobes on dorsal side. Basal-piece large, forming a large chitinous plate on ventral and lateral sides; membranous on dorsal side; membrane connecting it to lateral lobes large and allowing great movements of parts. No differentiated internal sac.

Enhydrus, sp.

This is the same type as *G. natator*, the median lobe being pointed and the lateral lobes pointed on the inner side of a widened tip. Basal-piece large, but connecting membrane not so large as in *G. natator*, and not allowing so much movement between basal-piece and lateral lobes. No differentiated internal sac.

Orectochilus dispar (Pl. XLIX figs. 43 and 43a).

Median lobe tubular, drawn to a point on the ventral side of the apex; median orifice situated on dorsal side of apex; median fora-

* F. Netolitzky (Deut. Ent. Zeitschr., 1911, p. 271) has discussed the Adephaga from the point of view of the lateral lobes.

men at base. Lateral lobes narrow and bluntly pointed, the distal half bearing fine hairs along edge. Basal-piece long and narrow. No differentiated internal sac.

The aedeagus of the Gyrinidae is of the trilobe type with well-developed basal-piece, and they should not be placed with the Dytiscidae, but near to the Hydrophilidae. The comparatively simple trilobe form and undifferentiated internal sac indicate a form of low specialisation (accompanied by extreme adaptive characters of the body). Information as to the mode of fertilisation in this family is very desirable.

Family HYDROPHILIDAE.

Forms examined: *Hydrophilus* (*Hydrous* of recent authors) *piccus* L., Europe; *H. ater* Fabr., Paraguay. *Anacaena ovata* Reiche, England. *Berosus luridus* L., and *B. signaticollis* Charp., Brockenhurst. *Laccobius ytenensis* Sharp, Brockenhurst. *Helophorus aquaticus* L., Brockenhurst. *Dactylosternum subdepressum* Cast., Panama.

Figs. 44-46a Pl. XLIX.

Hydrophilus piccus (Pl. XLIX fig. 44).

The aedeagus of this insect is the best known of any, as it has been figured and described by many writers. See especially Escherich, Zeitschr. Wiss. Zool. lvii. The median lobe is well developed, membranous, strengthened by three sclerites. A ring-like one (*a*) supports the median orifice, a thin rod-like one runs down the ventral surface, and a large one (*b*) covers the dorsal surface; the latter is narrow at the tip and broadens out basally, where it extends into a pair of median struts (*ms*), a keel runs down the centre, bifurcates about the middle and the keels continue on to the median struts. The lateral lobes are broad at the base, where they meet both dorsally and ventrally and embrace the base of the median lobe; from the base they taper off to a point at the apex. The basal-piece is formed by a large, shield-shaped sclerite (*bp*) with its lateral edges turned up, the dorsal side being membranous. When the muscles acting upon the median struts force the median lobe outwards, the fact of it being articulated to lateral lobes (at the point of articulation *pa*) causes it to turn dorsally upon that point, this at the same time forces the lateral lobes apart. This appears to be the action of all the trilobe types in which the lateral arms are free (not consolidated together) and the median lobe is articulated to the lateral

lobes. We have not examined one of these forms during copulation, but it is most likely that the lateral lobes are used to keep open the external orifice of the female. The internal sac is undifferentiated.

Laccobius ytenensis (Pl. XLIX fig. 45).

This is a trilobe form. Median lobe chitinous on dorsal side, membranous on ventral side whereon the median orifice is situate. Lateral arms curved, surrounding median lobe. Basal-piece large, membranous on dorsal side. Internal sac undifferentiated.

Berosus signaticollis (Pl. XLIX fig. 47).

Median lobe thin, tubular, slightly curved and pointed at apex; median orifice on ventral side of apex; median foramen at base; basal edge continued into two curved median struts (*ms*). Lateral lobes large, consolidated into one piece on the ventral side, forming a flattened trough into which the median lobe falls when at rest; point of articulation at base. Basal-piece large, forming a flattened trough into which the lateral lobes fall when at rest, the distal edge of the basal-piece being articulated to the middle of the ventral part of the lateral lobes. Internal sac undifferentiated.

In *B. luridus* the median lobe is slender and long, the lateral lobes slender and long and quite free. Basal-piece small and jointed to the lateral lobes in normal manner. Internal sac undifferentiated. The profound difference between these two otherwise allied species is of great interest.

Helophorus aquaticus.

The median lobe is short, broad at base and bluntly pointed at tip, where the median orifice is situate. Lateral lobes about same length as median lobe, broad at base and bluntly pointed at apex. Basal-piece longer than median lobe, shield-shaped, membranous on dorsal, chitinous on ventral side. Internal sac undifferentiated.

Dactylosternum subdepressum (Pl. XLIX figs. 46, 46a).

Median lobe flattened, broad at base, pointed at apex, the dorsal aspect being chitinous, the ventral membranous; the median orifice towards the base on ventral aspect (*mo*). Lateral lobes meeting together at base on ventral face, but wide apart on dorsal; tapering to a point at apex. Basal-piece small, chitinous all round, but narrow on dorsal aspect, and extending basally on ventral side, there somewhat shield-shaped. Internal sac undifferentiated.

The Hydrophilidae possess an aedeagus of the trilobe form, with well-developed median and lateral lobes and basal-piece, but with undifferentiated internal sac. This is a generalised type. *Berosus* departs from it furthest in *B. signaticollis*.

Family STAPHYLINIDAE.

Forms examined: *Gyrophæna pulchella* Heer, England. *Homalota londinensis* Sh.; *H. elongatula* Gr., and *H. pavens* Er., Brockenhurst. *Tachinus subterraneus* L., Brockenhurst. *Tachinoderus grossulus* Lec. (? North America, no locality ticket). *Ocypus cupreus* Rossi, Brockenhurst. *Staphylinus caesareus* L., Brockenhurst. *Philonthus* and *Gabrius*, numerous species. *Cecophilus erythrocephalus* Fabr., Australia. *Quedius ventralis* Ar., Brockenhurst. *Pinophilus rectus* Sh., and *P. mimus* Sh., Amazons. *Platyprosopus* sp., India. *Othius fulvipennis* Fabr., and *O. melanoccephalus* Grav., Brockenhurst. *Xantholinus glabratus* Grav., Brockenhurst, and *X. phoenicopterus* Er., Australia. *X. (Eulissus) chalybeus* Mann, Brazil. *Paedrus riparius* L., Brockenhurst. *Lathrobium brunnipes* Fabr., *L. fulvipenne* Grav., and *L. boreale* Hochh., Brockenhurst. *Stenus speculator* Lac., Brockenhurst. *Osorius* sp. near *ater* Perty, Trinidad. *Nodynus leucofasciatus* Lew., Japan. *Olophrum picum* Gyll., Brockenhurst. *Leptochirus edax*? loc. dub. *Ziroporus bicornis* Ol., Amazons. *Micropeplus fulvus* Er., England.

Figs. 61-74 of Plates LII, LIII and LIV are devoted to Staphylinidae.

Gyrophæna pulchella (Pl. LII figs 61, 61a).

Median lobe chitinous, tubular, flattened near tip and twisted and swollen slightly at base; median orifice narrow, on ventral side near apex; median foramen at base small. There are two pairs of spines on ventral side close behind median orifice. Lateral lobes large, broad and flattened; inner surface membranous, outer chitinous, and divided into several large sclerites; near apex there is a small articulated lobe bearing two stout hairs. The lateral lobes are attached to median lobe near base on ventral side of median foramen (*pa*). Internal sac medium size with a long flagellum (*fg*) arising from apex of sac and passing through median orifice.

This is a highly developed form of the Aleocharid type. The structure is very large in comparison with the size of the insect.

Homalota londinensis.

Median lobe broad and flattened; tip on ventral aspect curved downward, and drawn out into a fine point, tipped with a fine pin-head knob. Lateral lobes large and broad; on the lower margin, near base, arises a long curved flattened spine. Sac not examined.

Homalota elongatula.

Median lobe bulbous at base, membranous on dorsal side, chitinous on ventral, the distal chitinous edge prolonged into a laterally compressed curved tip. The lateral lobes large, flat, and rounded at apex.

Homalota pavens.

Median lobe swollen at base, chitinous on ventral side, membranous on dorsal, distal end not twisted. Lateral lobes large. Sac not examined.

Tachinus subterraneus (Pl. LII figs. 61, 61a).

Median lobe short and bulbous, the ventral aspect formed by a chitinous sclerite jointed at apex, the dorsal by a circular sclerite, with a semi-membranous connection between (*m*). The median orifice has a dorso-distal position and the median foramen is small with a ventro-medial position. The lateral lobes joined together to near tips, attached to median lobe near median foramen on posterior (ventral) side. Internal sac large and complex, with a flexible, chitinous sclerite (*a*) supporting each side; at the distal end there is a large egg-shaped chitinous body (*b*) with a short tube on one side on which the ejaculatory duct opens. The use of this hollow egg-shaped body we are unable to conjecture.

Tachinoderus grossulus.

Distal half of median lobe tubular, basal half bulbous; median orifice distal; median foramen on ventral aspect in median position; semi-membranous around middle portion of bulbous base. Lateral lobes small, amalgamated to near tip. Internal sac large, with bilobed diverticulum on ventral face, and small chitinous process at apex where the ejaculatory duct opens.

Ocypus cupreus (Pl. LII figs. 63, 63a, 63b).

In this form the median lobe is a strong, chitinous tube with a bulbous base, a semi-chitinous band (*m*) running round the bulb; the median orifice is distal; the median foramen small and ventral, at the junction of bulb and tube. The lateral lobes are amalgamated and form a broad, slightly-curved plate on the ventral aspect of the median lobe, the tip being slightly cleft. The internal sac large, with four large, round diverticula near base, covered with curved spines; the dorsal side covered with long strong hairs, the ventral with large curved spines, similar to those on the diverticula; the apex is drawn out thinner and has two constrictions near the end and the opening of the ejaculatory duct (*o*) near the tip on the ventral side is supported by two flat chitin sclerites; a small spine rises just beyond it. The sac shown in the figure is drawn from a specimen taken in copula; it had the position figured.

Creophilus erythrocephalus, has a median lobe somewhat like *O. cupreus*, but the lateral lobes form a single broad prong on the ventral face. Internal sac medium size with a short curved flagellum arising from apex.

Quedius; has a similar form of median lobe to *Ocypus*, and the lateral lobes form a single piece on its ventral side. In *Q. ventralis* (Pl. LII fig. 64) the internal sac is figured evaginated. In *Q. brevicollis* the internal sac has a pair of small diverticula near apex and the opening of the ejaculatory duct below them, also a larger pointed pair on the dorso-lateral part of the middle, and a round diverticulum on the ventral side near base, covered with semi-chitinous pegs.

Q. vexans (of our British collections) has median and lateral lobes of the same type, the internal sac being swollen at base and thin for the distal two-thirds; a pair of blunt diverticula arise from the side near the middle, and a backward-pointing one nearer the base on a median-ventral line.

Pinophilus rectus (Pl. LIV figs. 71, 71a).

Median lobe large, bulbous at base, with semi-membranous strip (*m*) running across to near apex; apex with dorsal edge projecting beyond ventral; median orifice on ventral side of apex; median foramen small, on ventral side about one-fourth from base. Lateral lobes thin narrow strips, articulated to median lobe on ventral edge of median foramen. Internal sac about 15 mm. long, thin, tubular, coiled up in median lobe when invaginated. Arising from apex of sac is a fine chitinous flagellum as long as the sac, with the opening of the ejaculatory duct at its tip. At the base of the

sac are three irregular chitin plates (*b*) with a narrow strip of chitin (*a*) running some way along the sac. These appear to form guides for the flagellum.

P. minus has a similar sac and flagellum which make ten complete coils in the median lobe, like a coil of rope, and measure 20 mm.

In *Pinophilus* where there is an enormously long sac and flagellum, coiled up within the median lobe, it is not likely that the sac is evaginated, but the flagellum is thrust out and the basal part of the sac folded up like a concertina bellows; nor is it likely that the whole of the long flagellum is everted, but the muscles acting upon the coils cause it to operate like a coiled spring, the distal end being thus thrust out and retracted when the muscular pressure is relaxed.

Othius fulvipennis (Pl. LIII fig. 65).

Medium lobe bulbous with ventral distal edge projecting; median orifice dorso-distal, median foramen small, ventro-medial; a semi-membranous band running round bulbous part of median lobe. Lateral lobes thin, separate, attached to median lobe on ventral edge of median foramen. Internal sac large, apex forming two diverticula; on the larger diverticulum the ejaculatory duct opens; a small bilobed diverticulum on dorsal side and a pair of large diverticula on ventral side; between these last processes and the base are two pairs of curved chitinous spines.

Othius melanocephalus (Pl. LIII fig. 66).

Very much like *O. fulvipennis*, but the internal sac differs greatly; on each side near apex is a fine long diverticulum (*a*).

Xantholinus glabratus (Pl. LIII figs. 67, 67*a*, 67*b*).

In this species the bulbous median lobe is of an extreme form, being egg-shape, with a small membranous distal portion to which the greatly reduced lateral lobes are attached. The median lobe is formed of dorsal and ventral sclerites, round, and connected by a semi-membranous band (*m*); the median orifice (*mo*) is at the distal end, and the median foramen (*mf*) slightly in front (or basal) on the ventral face. These two openings are separated only by a chitinous plate (*a*) formed by the basal part of the lateral lobes which are extremely reduced. The internal sac is three times the length of the median lobe, tubular, and studded with large teeth, curved basally,

A less modified form is found in *Xantholinus* (*Eulissus*) *chalybeus* (Pl. LIII figs. 68, 68a) from Brazil ; in which the distal end of the median lobe is short and tubular, drawn out into a point on the ventral side, the median foramen being situate in the ventral chitinous sclerite at the base of the short tubular distal end.

X. phoenicopterus is also less modified than *X. glabratus*, the lateral lobe being much larger and the median foramen on the ventral sclerite.

Paederus riparius (Pl. LIII figs. 69, 69a).

The median lobe broad, slightly flattened and slightly bulbous at base, the dorsal distal margin projecting beyond the ventral, the median orifice being on ventral face beneath this projection ; the median foramen small, near base slightly dorsal. The lateral lobes broad, flattened, with curved pointed apices projecting beyond end of median lobe, closely applied to sides of it, and attached to it near the ventral edge of median foramen. Internal sac with large curved spine (*a*) at base. Apex of sac not examined.

Lathrobium brunnipes.

The median lobe bulbous and membranous, except on the ventral basal part which is chitinous ; median orifice at tip ; median foramen small, about the middle. Lateral lobes consolidated into a single body, broad at base and narrow at apex where there are two small points ; a groove runs along the ventral side. They form the strongest part of the aedeagus and are consolidated to the ventral face of the median lobe from the edge of the median foramen to the tip. Internal sac not examined.

L. fulvipenne is of the same type as *L. brunnipes*, but the left lateral lobe appears to be absent and the right is large and projects as a curved spine ; there is also a chitinous support on the dorsal side of the median orifice.

L. boreale.

The same type as *L. brunnipes*, the lateral lobes being consolidated into a single piece, the tip being pointed and turned down like a small hook, the median ventral line being keeled, not grooved. The dorsal margin of the median orifice is supported by a small chitin plate and a strong chitin piece with two hooks at the end projects from the basal part of the internal sac. On each side of the internal sac, near the base, is a patch of chitinous flat scales, prolonged into prongs on the basal edge. When the sac is evaginated the two-hooked piece on the dorsal side of the base turns over and

points basally. The aedeagus in *Lathrobium* is extremely irregular and asymmetrical in structure.

Stenus speculator (Pl. III figs. 70, 70a).

Median and lateral lobes on same plan as *Paederus riparius*. Internal sac large, with two chitin strips (*a*). These chitin strips are continuations of the chitin of the ventral surface of the median lobe.

Osorius sp. (Pl. LIV fig. 72) from Trinidad, apparently has the lateral arms entirely missing, or reduced to a narrow, small band slightly distal of the median foramen on the ventral side (*ll*). The median lobe is bulbous with the dorsal side semi-membranous and the ventral distal edge pointed. The internal sac is large with two diverticula near base, one bearing short hairs on the tip, and a large curved diverticulum at end, ventral of the opening of ejaculatory duct.

Nodynus leucofasciatus.

Median lobe bulbous at base, chitinous on ventral side and drawn out distally to a point, the dorsal side being membranous; median orifice at distal end on dorsal side; the median foramen small, on ventral side and about the middle. Lateral lobes fairly broad, pressed against sides of the median lobe and projecting slightly beyond tip, attached to median lobe on ventral side of edge of median foramen. Internal sac without chitinous armature.

This is very Silphid-like, but the absence of the basal-piece separates it from that group.

Olophrum piceum is very like *Nodynus*, the lateral lobes being flattened and curved. Internal sac long, flattened and coiled up in the median lobe; its surface covered with hair-like scales.

Leptoehirus, sp.

Median lobe tubular, curved ventrally near the base; semi-chitinous on dorso-basal part. Median orifice on dorsal side of tip; median foramen small, near base on ventral side. Lateral lobes small, about one-fifth the length of the median lobe. Internal sac large, but not examined.

Zirophorus bicornis (Pl. LIV fig. 73).

Has a thin, slightly flattened median lobe, strongly chitinised and curved at the base, and semichitinous along the dorsal basal part (*m*). The lateral lobes are articulated to the curved base and consist of narrow lobes free along their whole length. Median orifice at distal end, median foramen at base. Internal sac short and without armature.

Micropeplus fulvus (Pl. LIV fig. 74).

This is a Staphylinid type, the median lobe being large and bulbous at the base; the median orifice at the apex large, the median foramen small and one-fourth from base on ventral side. The lateral lobes are so completely amalgamated to the median lobe that it is very difficult to distinguish them, but they are of fair size and lie along the ventro-lateral portion of the median lobe. The internal sac is large, complex, covered with small chitinous spines and supported by chitinous patches.

It is among the Staphylinidae that we have found the greatest modification of a single type. In this family the internal sac reaches a high state of specialisation and the modification of the median lobe for the evagination of the sac by blood-pressure is carried to perfection. This is brought about by modifying the tubular median lobe into a bulb having chitinisations on the dorsal and ventral aspects, with a band of membrane between, so that the dorsal and ventral sclerites can be brought together by muscular contractions and so exert pressure of a fluid on the sac and turn it out.

The Staphylinidae are distinguished from the Silphidae by the absence of a basal-piece. Since our paper was written Dr. L. Weber of Cassel has published a very valuable paper on the male genitalia of Staphylinidae (Festschr. Ver. Cassel, 1911). We are, however, not prepared to accept his interpretation of the very abnormal genus *Habrocerus*, as to which he himself speaks with considerable diffidence.

Family SILPHIDAE (= families *Silphidae*, *Liodidae*,
and *Clambidae*, Reitter).

Forms examined: *Silpha* (*Phosphuga*) *atrata* L., England. *S. obscura* L., England. *S. japonica* Motsch., Japan. *S. ? analis* Chevr., Panama. *Necrodes osculans* Vig., Woodlark Island. *Necrophorus mortuorum* Fabr., England. *Astagobius angustatus* Schm., Carniola. *Bathyscia* (sp. not in Brit. Mus.), Piedmont. *Liodes* (*Anisotoma* of certain authors) *humeralis* Fabr., England. *Clambus minutus* St., England.

Figs. 48-54, Plates XLIX and L, are devoted to this group.

Silpha atrata (Pl. XLIX fig. 48).

Median lobe flattened, broad, with ventral side chitinous and dorsal membranous; median orifice at distal end; median foramen small, situate in the basal part of the ventral chitinous plate. Lateral lobes broad at base, tapering to rounded point at apex. A thin ring of chitin runs over the base of median lobe (*bp*) and joins the bases of the lateral lobes; this represents the basal-piece. Internal sac large, rounded at the apex, with three large, round diverticula at base (*b*), covered with long, fine hairs, thickest on the dorso-basal surface.

The median lobe is not consolidated to the basal-piece and can be dissected away.

The figure shows the apex of sac collapsed, the broken lines (*c*) show the more normal shape.

Silpha obscura (Pl. L figs. 49, 49a).

Median lobe large, extending beyond the basal-piece; the ventral and lateral faces of the distal half chitinous, the dorsal side and all the basal half membranous, except a small strip of chitin (*a*) extending from the median foramen (*mf*) towards the base. The median orifice on dorsal side of tip; the median foramen small, placed about middle of ventral side. Lateral lobes fairly broad, curved at tips and bearing a small knob, they are pressed closely to the latero-ventral surface of the distal half of the median lobe. The basal-piece is ringlike (*bp*). Internal sac large; details not examined.

Silpha japonica.

Of the same type as *S. atrata*. The internal sac is flattened horizontally and constricted in the middle, the dorsal surface is covered with long, silky hairs.

Silpha analis (Pl. L fig. 50).

Though probably a different genus this is similar to the various species we have already remarked on. The basal-piece is of rather larger extent. Internal sac large with a large curved prong (*a*) on each side near the base, basal part covered with short hairs, distal part with granulated surface.

Necrodes osculans.

The aedeagus is of the *Silpha obscura* type. The median lobe broad, with distal half chitinous, especially on the ventral aspect, the ventral half membranous; the median orifice dorso-distal, and the median foramen ventro-medial. The lateral lobes each broad

at base, the apex slightly curved. The basal-piece consists of two small narrow sclerites, attached to the base of the lateral lobes, but they do not meet on the dorsal side.

Necrophorus mortuorum (Pl. L fig. 51).

Median lobe chitinous on ventral and lateral aspects, membranous on dorsal aspect; median orifice large, on dorsal aspect of apex; median foramen small, on ventral aspect about one-fourth from base. Lateral lobes broad at base, tapering to blunt point, bearing several hairs. Basal-piece (*bp*) slender and ring-shaped. Internal sac large, but details not examined.

Astagobius angustatus.

The median lobe large, slightly flattened and curved; the median orifice on the ventral face of apex, the dorsal edge being pointed; median foramen large, at base. Lateral lobes long and thin; basal-piece formed by a small curved sclerite on ventral face, but not meeting on dorsal. Internal sac large, armature not observed.

Bathyscia, sp. (Pl. L figs. 52, 52*a*).

Median lobe tubular, slightly flattened towards apex on dorsal face where it graduates to a point; median orifice at apex on dorsal face; median foramen (*mf*) at base, as large as the diameter of the median lobe, the edge being strengthened by a thickening of the chitin (*a*). The tegmen consists of a broad ring-shaped basal-piece (*bp*) with a pair of thin lateral lobes lying along each side of the median lobe, the basal-piece being slightly posterior of the base of the median lobe. Internal sac large, extending through the median foramen. Arising from the apex of the sac is a short, stout flagellum (*c*), along which the ejaculatory duct continues and opens at its tip. The dorsal face of this flagellum is chitinous (*a*) and broadened at the base where the corners articulate with a Y-shaped (*y*) support (Jeannel's Y-piece); the ventral face of the flagellum is membranous, except at the tip where the chitin forms a short fine tube.* Fig. 52*a* represents the internal flagellum (*c* of fig. 52) on a much higher scale of magnification.

Liodes humeralis (Pl. L figs. 53, 53*a*, 53*b*) is of the same type as *Bathyscia*. The median lobe is chitinous, strongly bent at the basal third, swollen at base and pointed at apex; the median orifice is at apex on ventral face; the median foramen at base, and as large as the enlarged base of median lobe. The tegmen consists of a

* On this group reference may be made to an important memoir by Jeannel, Arch. Zool. exp. v, 1910.

ring-like basal-piece, broader on dorsal than on ventral aspect, with a pair of narrow, pointed lateral lobes pressed close to the sides of the median lobe. The internal sac not large, but with complex armature at apex (53a, 53b). A flat, curved median chitin-piece (*b*) is attached to the internal sac by a large chitin knob (*c*) through which the ejaculatory duct runs and opens on the end of the median piece; a chitin plate (*d*) with a second chitin knob (*e*) gives it greater support. To each side of the chitin knob (*c*) is attached a flattened pointed process, thickened at its base at the point of attachment, one is slightly longer than the other.

Clambus minutus (Pl. L fig. 54).

Median lobe a thin, partly flattened, tube, with the dorsal distal part drawn out into a curved process hooked at the tip, the ventral distal part into a semi-membranous tongue. The lateral lobes are amalgamated for two-thirds of their length and form a broad shallow plate with the distal third forming unequal points, bearing a couple of stout spines. The basal-piece ring-shape (*bp*). Internal sac not examined.

Among the Silphidae s. l. that we have examined there are three distinct types of aedeagus. The first is represented by *Silpha*, in which the median foramen is small, the median lobe collapsible on the dorsal aspect and forms a collapsible bulb by means of which the internal sac is evaginated by fluid-pressure, and the sac bears no chitinous armature. In the second the median foramen is large, and the median lobe is not collapsible and does not function as a bulb for the evagination of the sac, and the sac bears chitinous armatures.

The third type has the lateral lobes amalgamated together to form one piece, and the median lobe is tubular and not collapsible.

These characters do not quite agree with the divisions into families of the Silphid allies. As, however, the recent authorities are not in accord on this point, and as we have studied a very small percentage of the known forms, we have treated the assemblage as one family. But we hope our doing this will not be interpreted as supporting either one view or the other.

The Silphid type approaches the Staphylinid type, but the presence of a reduced basal-piece serves to distinguish the two.

Family LEPTINIDAE.

Form examined: *Leptinus testaceus* Müll., Brockenhurst.

L. testaceus (Pl. LI figs. 55, 55a).

Median lobe large, chitinous on dorsal aspect, where it is drawn out into a point and on the sides, semi-membranous on the ventral aspect; median orifice on the ventral aspect of the distal end (*mo*); median foramen large at basal end, and proceeding somewhat along dorsal side (*b*). Lateral lobes thin narrow bodies lying along the dorso-lateral parts of the median lobe and projecting somewhat beyond its tip. Basal-piece well developed, forming a ring through the base of which the median lobe passes and projects beyond, basally. Point of articulation on dorsal side. This basal-piece is distinct but of a semi-chitinous nature. Internal sac large, projecting through the median foramen; it bears a patch of hairs near its apex, and about the middle a long slender chitin rod (*a*) attached to the sac by a broad square base; the ejaculatory duct does not pass through it. This differs but little from certain Silphidae.

Family PLATYPSYLLIDAE.

Form examined: *Platypsylla castoris* Rits., N. America.

P. castoris (Pl. LXXVII fig. 229).

This comes near to *Leptinus* from which it differs only in details.

Median lobe tubular, pointed at apex and greatly enlarged on basal two-fifths; median orifice on ventral face near apex; median foramen large at base. Tegmen consisting of a basal-piece surrounding the median lobe anterior to the basal enlargement, and a pair of narrow lateral lobes situate on the dorsal face. Internal sac smaller than in *Leptinus* and not passing through the median foramen when at rest, covered with hairs and flattened pointed scales; a thin flagellum arises from the apex.

We are indebted to Mr. E. A. Schwarz for the opportunity of examining this interesting species.

Family SCAPHIDIIDAE.

Form examined: *Scaphidium quadrimaculatum* Ol., Brockenhurst.

S. quadrimaculatum (Pl. LIV fig. 76).

This is a characteristic Staphylinid type. Median lobe with distal half forming a wide tube, basal half bulbous, with a membranous

band round the bulb (*m*) ; median orifice large, at distal end, with ventral edge projecting beyond dorsal; median foramen small on ventral face, about one-third from base. Lateral lobes attached to median lobe on ventral aspect, at the ventral edge of the median foramen. Internal sac large, with patches of short hairs ; details not studied.

Family TRICHOPTERYGIDAE.

Form examined: *Trichopteryx grandicollis* Mann., England, and some others.

T. grandicollis (Pl. LXXVII figs. 231 and 231*a*).

The aedeagus consists of a short tube with a pair of hooked struts on the ventral side of the base, the median orifice large, with the ventral edge produced into a blunt point. Internal sac large, bearing small spines and a small chitin-plate (*a*) on the dorsal face and some chitinisation on the ventral (*b*) which we have not definitely made out. The position of the opening of the duct on the sac was not observed.

We could find no trace of tegmen. A small plate with a central strut exists below the aedeagus, but it appears to be a body sclerite and not the tegmen.

At present we are unable to associate this with any other form.

Euryptilium marginatum has the organ longer, with the ventral margin of the median orifice projecting, pointed, and turned down.

Mr. H. Britten has submitted to us for examination dissections of *T. grandicollis*, *T. thorica*, *T. bovina*, *T. brevis*, *Euryptilium marginatum*, *Ptiliolium spencei* and an unidentified species. These are each and all easily recognised by the aedeagus.

Family CORYLOPHIDAE.

Forms examined: *Sacium politum* (coll. Matthews), hab. ? *Corylophus cassidioides* Marsh., England.

Fig. 75 Pl. LIV.

Sacium politum (Pl. LIV figs. 75, 75*a*).

Median lobe a large flattened tube, the median orifice at the distal end, the ventral edge extending beyond the dorsal and pointed; the median foramen very small at the basal end. Tegmen forming a

"ring-piece," the cap (*a*) or lateral lobes forming a wide curved plate slightly emarginate; the basal-piece forming a large shield-shaped plate with a deep keel down the centre (*b*). Internal sac large, with complex armature.

Corylophus cassidioides is of the same type. At present we cannot directly connect this to any other type; the small median foramen with the internal sac contained in the median lobe is unique among the "ring" forms, where it is the rule to have a large median foramen and the internal sac passing through it, when not evaginated.

Family SCYDMAENIDAE.

Forms examined: *Stenichnus collaris* Müll., England. *Eumicrus* (recently *Scydmacnus*) *tarsatus* Müll., England. *Leptomastax coquereli* Fairm., Corfu.

Figs. 56, 56*a*, *b* and *c*, 57 Pl. LI.

Stenichnus collaris (Pl. LI figs. 56, 56*a*, 56*b*, 56*c*).

The distal portion of the median lobe forms a short thick irregular tube; the basal part being curved under and prolonged into a flattened narrow process (*f*), a band of membrane (*m*) connecting the two portions; the median orifice is large, at the distal end; the median foramen small, situate on the dorsal face about two-thirds down the tubular distal end of the median lobe. Lateral lobes narrow flat processes, attached to the median lobe at the dorsal edge of the median foramen. Internal sac short but very complex (56*c*). On the dorsal face there is a membranous surface bearing a pair of keels studded with chitinous teeth (*g*) which converge together in the centre above the opening of the ejaculatory duct; on the ventral half is a broad chitinous plate somewhat shoe-shaped in lateral view (*a* and *b*), bearing a pair of small toothed processes (*h*).

We would like to call attention to the great importance of recognising the mobility of the internal sac and concomitantly the variation in the position of the sac armature, especially when it closes the median orifice. Unless this is understood the shape of the aedeagus will appear to vary greatly in certain species. In the figures we give, fig. 56 shows a side view with sac invaginated, 56*b* shows the sac partly evaginated, and 56*c* with it entirely evaginated, or nearly so; 56*a* gives a ventral view of 56*b*.

Eumicrus tarsatus (Pl. LVII fig. 57).

Median lobe tubular, slightly curved, with large median orifice at distal end and small median foramen at base. Lateral lobes large, broad and closely pressed to sides of median lobe; they extend beyond the end of the median lobe where the tips are consolidated into a single point, entirely enveloping the ventro-apical portion of the median lobe. Although the lateral lobes are pressed very closely to the median lobe, yet they are not consolidated thereto, and can be parted without damage. Internal sac small with a curved chitinous process (*a*) bearing the opening of the ejaculatory duct at its tip.

Leptomastax coquereli.

Median lobe similar to *Eumicrus tarsatus*; the lateral lobes are broad and flat but do not meet and become consolidated at their tips. Internal sac small, with a chitinous process ending in a short flagellum on which the ejaculatory duct opens.

The family Scydmaenidae exhibit a great diversity of form, but all appear to be of one type. Median lobe more or less tubular with a large median orifice and a small median foramen more or less inclined to the dorsal face. The lateral lobes articulated to the base of the median lobe on the dorsal face of the median foramen. Internal sac bearing armature. The point of articulation being on the dorsal side of the median foramen distinguishes this family from the Staphylinidae wherein the point of articulation is on the ventral side.

The distinguished French entomologist, M. de Peyerimhoff, has published a memoir on the male structures of Scydmaenidae, in which he expresses the opinion that the structures are in some species variable. We would point to our remarks under *Stenichnus collaris* as possibly explaining the discrepancies he remarks on.

Family PSELAPHIDAE.

Forms examined: *Sagola* sp. (not in Brit. Mus.), New Zealand. *Trichonyx sulcicollis* Reich., Brockenhurst. *Bryaxis impressa* Panz., and *B. juncorum* Leach, Brockenhurst. *Physa inflata* Sharp, New Zealand. *Palimboldus* sp. (not in Brit. Mus.), New South Wales.

Figs. 58, 59, 60 and 230 Pls. LI and LII.

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Sagola sp. (Pl. LII fig. 59).

Median lobe long, slender, tubular and slightly curved, the median orifice at apex, the ventral edge projecting beyond the dorsal. Lateral lobes large, flattened laterally and lying on each side of median lobe, with their base in intimate union with the base of the median lobe. The piece we call basal-piece (*bp*) appears to belong to the lateral lobes and not to be a true basal-piece, but this point is obscure. Internal sac undifferentiated.

Trichonyx sulcicollis.

Median lobe bulbous with circular, membranous patch on dorsal face; median orifice at distal end, closed by a chitin plate which is attached at the base of the internal sac; this plate moves when the sac is evaginated; median foramen small, about two-thirds from base. Lateral lobes short, flattened, applied closely to the ventral face of the distal end of the median lobe. Internal sac large, armed with strong chitinous plates.

Bryaxis impressa (Pl. LXXVII figs. 230, 230*a* and *b*).

This appears to be much on the same plan as *Sagola*, but the lateral lobes in their basal part are consolidated to the sides of the median lobe, and their more median portions apparently meet, while their outer portions remain free, divergent and pointed. If a section be taken through the middle of the aedeagus it should include three lumens, in the middle that of the median lobe (*d* of fig. 230*b*) and another on each side, *c*, the lumen of the lateral lobe. Internal sac undifferentiated. There is considerable difficulty in the interpretation and delineation of this structure, as regards the distal portions of the median strips of the lateral lobe. In the figures 230 and 230*a* it is assumed that they pass beyond the median orifice and then meet at the point *a*.

Bryaxis juncorum.

The aedeagus is on the same plan as *B. impressa*, but is shorter and more bulbous; the lateral lobes are consolidated to the median lobe.

Physa inflata (Pl. LI fig. 58).

Median lobe bulbous, ventral and dorsal walls chitinous with a membranous band (*m*) around the middle, median foramen small, ventral and nearly median. The lateral lobes hard to distinguish from median lobe but appear to be the two pointed sclerites on each side of median orifice (*ll*), but it is possible that the median sclerite (*a*) on the ventral distal part of the median lobe represents

the consolidated and reduced lateral lobes. Internal sac large, swollen towards the apex where it is produced into two small diverticula, between which the ejaculatory duct opens, the apical dorsal part bearing spines, and a large spine on each side a third from the base.

Palimboldus sp. (Pl. LII fig. 60).

Median lobe bulbous with right edge of median orifice prolonged into point; except for a batch of membrane on dorsal side (*m*) the median lobe is chitinous; median foramen small, on ventral face. Lateral lobes small, subcircular bodies applied closely to median lobe slightly posterior of the median foramen. Internal sac well developed with two chitin rods (*a*) supporting the ventral surface and forming two rounded projections beneath the opening of the ejaculatory duct.

The few forms of Pselaphidae that we have examined show very interesting differences which future investigation will probably show to be characteristic of distinct groups, unless connecting forms should be found. The type is closely allied to the Staphylinid. The possibility of *Bryaxis* having a true basal-piece included in the aedeagus requires investigation, as the possession of such a structure would prevent their being regarded as direct offshoots of the Staphylinidae.

Family SPHAERITIDAE.

Form examined: *Sphaerites glabratus* Fabr., Scotland.
Fig. 78 Pl. LV.

Sphaerites glabratus (Pl. LV figs. 78, 78a).

Median lobe thin, only the tip visible; median orifice at tip. Lateral lobes large, consolidated together for the greater part of their length on the ventral, and for half their length on the dorsal face, thus forming a tube in which the median lobe lies. Basal-piece small and asymmetrical, the chitination forming a broad circular band. Internal sac undifferentiated. This is very like *Syntelia*.

Family SYNTELIIDAE.

Form examined: *Syntelia histerooides*, Japan.

Syntelia histerooides (Pl. LV figs. 77, 77a).

Median lobe well developed, long, curved, tubular, with a pair of median struts. Lateral lobes very long and curved towards their

pointed apices, consolidated together for the greater part of their length. Basal-piece small, symmetrical, with the opening on the ventral (?) face.

This comes near to *Sphaerites*.

Family NIPONIIDAE.

Form examined: *Niponius canalicollis*, Japan.

Fig. 82 Pl. LV.

Niponius canalicollis (Pl. LV figs. 82, 82a).

Median lobe tubular, slender and long; lateral lobes longer than median lobe and enveloping them. Basal-piece forming a long tube, constricted near its base and bent. Internal sac undifferentiated.

This form of aedeagus is nearest to *Syntelia* but differs in having the tubular basal-piece long, a character in itself not of family importance.

Family HISTERIDAE.

Forms examined: *Hister cadaverinus* Hoffm., England. *Pachylister chinensis* Quens., China. *Macrolister maximus* Ol., Africa. *Oxysternus maximus* L., Guiana. *Hololepta elongata* Er., Andaman Islands. *H. arcifera* Mars., Cameroons. *Saprinus nitidulus* Fabr., England. *Teretriosoma stebbingi* Lewis, India.

Figs. 79, 80 and 81, Pl. LV, relate to *Histeridae*.

Hister cadaverinus (Pl. LV figs. 79, 79a).

Median lobe well developed, chitinous, slightly curved, with a large flange running round the lateral and distal edges of the apical half (*a*), forming a cavity in which the apical armature lies when the median lobe is at rest. This median armature is a pair of two-pronged structures, amalgamated at their bases and articulated to the base of the median lobe; when the median lobe is withdrawn between the lateral lobes at rest, the armature lies in the cavity, but when it is thrust out the armature turns back. There is a pair of short median struts. Tegmen consisting of a small basal-piece with very large lateral lobes amalgamated on their ventral side to the tip, and on the dorsal side along the basal half. Internal sac undifferentiated.

Macrolister maximus.

A figure is given of this with the median lobe erected (Pl. LV fig. 80).

Oxysternus maximus.

Median lobe rod-like, dilated at the tip into a cleaver-shaped process. Basal-piece moderately long, slightly asymmetrical, with a large membranous area on one aspect, just anterior to its junction with the lateral lobes. Lateral lobes very long, coalesced on their basal portions to form a very hard tube, the apical two-fifths forming a half tube, or trough, at the basal portion of which is the articulation of the median lobe. The rod-like, very hard median lobe renders it pretty certain that the sac remains undifferentiated. The aedeagus is here a beautiful structure with very solid chitinisation.

Hololepta elongata (Pl. LV figs. 81, 81a).

The aedeagus is flattened and thin, the basal-piece more than two-thirds the length of the lateral lobes; the lateral lobes amalgamated along the dorsal surface to the tip and along the ventral surface for the basal two-thirds. The median lobe is greatly reduced.

Saprinus nitidulus.

Median lobe small, only the tip visible. Lateral lobes very large, consolidated together along their entire length, with the tips slightly flattened and turned down; this forms a complete tube with an opening at the tip on the dorsal side. Basal-piece very small, asymmetrical. Internal sac small, apparently not differentiated.

Teretriosoma stebbingi. We are indebted to Mr. Lewis for the opportunity of examining this rare and interesting Histerid. The individual was in a very decayed condition and the preparation was not very successful, but it shows that this form departs from the other Histeridae we have examined by the shape of the lateral lobes, which are flattened divergent laminae. Their conjunction with the basal-piece seems to be more intimate than usual.

The four families *Histeridae*, *Synteliidae*, *Sphaeritidae* and *Niponiidae* are so closely related by the aedeagus, that they might form one family, in which the Histeridae would include the higher developments. Its characteristics are the existence of a basal sclerite having no power of movement over the median lobe, and extremely large lateral lobes more or less amalgamated to form a tube. The type is extremely different from Staphylinidae. But the approximation to the Byrrhidae is clear.

Family PHALACRIDAE.

Forms examined: *Phalacrus grossus* Er., Spain. *Litolibrus obesus* Sharp, Panama. *Olibrus corticalis* Panz., England.

Figs. 83 and 84 Pl. LVI are Phalacridae.

Phalacrus grossus (Pl. LXI figs. 83, 83a).

Median lobe broad and flattened; median orifice on dorsal face at apex; median foramen large. Tegmen forming a ring-piece. The "cap-piece" formed of the two flattened lateral lobes consolidated on the dorsal side to near their apices, and a large flat plate, turned down along the lateral edges, the basal corners meeting together on the ventral side of the median lobe, where the ring is asymmetrical. Internal sac large and complex. There is a pair of long tubular glands which open on the apex of the sac, one on each side of the opening of the ejaculatory duct. As our specimens were dried we could not examine the testes to see if these glands were extra, or if there were the usual ones having an abnormal opening. In *Olibrus corticalis* these glands are not present in this position.

Litolibrus obesus (Pl. LVI fig. 84).

Median lobe broad and flattened, slightly bent near the base where a flange (*a*) runs along the dorsal face; median orifice on dorsal aspect at tip; median foramen large, on ventral side of base. Tegmen forming ring-piece. Lateral lobes small, consolidated together and forming a pointed, flattened plate bearing a pair of small curved hooks; basal-piece long and narrow on dorsal side, broadened at the base where it encircles the median lobe, having two deep emarginations causing the median central portion (*b*) to project as a tongue. Internal sac large, bearing a pair of double claws and a pair of small plates, as armature.

Family MONOTOMIDAE.

Form examined: *Monotoma conicicollis* Guér., England.
Fig. 85 Pl. LVI.

Monotoma conicicollis (Pl. LVI figs. 85, 85a).

Median lobe short, broad, flattened, and slightly curved; median orifice at tip, the dorsal edge projecting beyond the ventral and pointed; median foramen at base and of large size. From the ventral edge of the median foramen proceed two long struts (*ms*).

Tegmen (fig. 85a) forming a ring-piece, the dorsal part being a hood-shaped body, with a thin piece proceeding from each basal corner and consolidating on ventral side of median lobe. Internal sac very large, bearing armature near base (b) and towards apex (a).

Family NITIDULIDAE.

Forms examined: *Psilotus atratus* Reitt., Chiriqui. *Cychramus luteus* Fabr., England. *Ips* (*Glischrochilus* of various authors) *japonius* Motsch., Japan.

Figs. 87 and 88 Pl. LVI.

Psilotus atratus (Pl. LVI fig. 87).

Median lobe tubular, broad and flat, with single median strut. Tegmen forming a large broad curved plate or hood, on dorsal face, with a small dorsal median projection (a) from base, the basal corners meeting and consolidating on ventral side of median lobe. Internal sac large, the opening of ejaculatory duct at apex, where it is supported by two chitin rods consolidated together at tip (b) round the duct opening.

Ips japonius (Pl. LVI fig. 88)

is of the same type as *P. atratus*; and so is *Cychramus*, the "hood" being much larger than the median lobe.

The family Monotomidae comes near to these forms, as also does Helotidae. On the other hand, *Rhizophagus* does not belong to Nitidulidae. Whether it can be satisfactorily placed in *Cucujidae* (where we have treated of it, cf. fig. 101), can only be determined by a much more extensive survey of the *Cucujidae* than we have made.

Family BYTURIDAE.

Form examined: *Byturus tomentosus* Fabr., England.

Fig. 86 Pl. LVI.

Byturus tomentosus (Pl. LVI fig. 86).

Median lobe long, slender, and pointed; median orifice at tip on dorsal face; median foramen at base. Tegmen forming a close-fitting sheath, the distal half chitinous, the basal half membranous, with a strip of chitin supporting each side (a); and a Y-piece with a long stalk (b) supporting the ventral aspect. Internal sac undifferentiated.

This type is similar to Trogositidae.

Family TROGOSITIDÆ (or *Ostomidae*, or *Temnochilidae*).

Forms examined: *Temnochila virescens* Fabr., Mexico. *Alindria grandis* Serv., Africa. *Leperina*, sp. n.? aff. *adustae* Pasc., Australia. *Thymalus limbatus* Fabr., Brockenhurst.

Figs. 89 and 90 Pls. LVI and LVII.

Temnochila virescens (Pl. LVI figs. 89, 89a).

Median lobe long, flattened laterally, formed by a trough-shaped chitin plate (*a*) on ventral aspect and membrane on dorsal aspect (*b*), with a chitin strut round median orifice at distal end (*c*). Tegmen formed into a sheath; lateral lobes distinct and only amalgamated at base; basal-piece large and tubular, chitinous on dorsal and ventral aspects, membranous on sides. Internal sac undifferentiated.

Alindria grandis is of the same type, but the division between lateral lobes and the basal-piece is obliterated.

Thymalus limbatus (Pl. LVII figs. 90, 90a).

Median lobe long, straight, flattened laterally. Tegmen forming a sheath with lateral lobes consolidated together on the ventral aspect, basal-piece long, tubular, with a strong strut on the dorsal aspect at base (*a*).

Leperina aff. *adustae* is of the same type but has the lateral lobes free.

It is possible that this type is a development of a trilobe type through such a form as *Aulonium*. *Byturus* belongs near this family.

Family COLYDIIDÆ.

Forms examined: *Enarsus bakewelli* Pasc., New Zealand. *Tarphiomimus indentatus* Woll., New Zealand. *Aulonium bidentatum* Fabr., Guatemala. *Deretaphrus ignarus* Pasc., Australia. *Cerylon histeroides* Fabr., England.

Figs. 91-95 of Pl. LVII relate to the above-named forms.

Enarsus bakewelli (Pl. LVII figs. 92, 92a, 92b).

Median lobe nearly as long as tegmen, chitinous on dorsal and lateral aspects, membranous on ventral (*a*); median orifice on ventral aspect near apex. Tegmen consists of a large basal-piece formed of a ventrally-placed sclerite, the dorsal aspect membranous, and a pair of

lateral lobes joined together on their ventral aspects and forming a large plate ; the median distal portion of the plate projecting between the distal ends of the lateral lobes as a free process, truncate at tip (*b*). No differentiated internal sac.

In this species there is a distinct abdominal plate between the anus and aedeagus (*lv*), which we think must be the last ventral sclerite of the body.

Tarphiomimus indentatus is of a similar type (Pl. LVII fig. 93).

Aulonium bidentatum (Pl. LVII figs. 91, 91*a*).

Median lobe large, somewhat flattened ; median orifice near tip on ventral face. Tegmen formed of a large basal-piece, chitinous on ventral and membranous on dorsal aspect, and a large piece, formed of the lateral lobes consolidated together to near their tips, on the ventral face.

Deretaphrus ignavus (Pl. LVII figs. 94, 94*a*).

Median lobe long, slender and tubular, with median orifice at tip on dorsal side, median foramen at base, which is slightly swollen. Tegmen consisting of two short, broad lateral lobes, rounded at tip and bearing a strong curved spine at base, between which the median lobe passes. Basal-piece short, projecting as two short struts (*a*) at base. Internal sac undifferentiated.

Some other species (which cannot be determined but are not *D. piceus*, the type of the genus) are of the same construction with slight difference in details.

Cerylon histeroïdes (Pl. LVII fig. 95).

The aedeagus consists of a long, tubular median lobe, swollen at its apex, across which is the median orifice ; and a small ring-shaped tegmen articulated at the base of the median lobe. Internal sac complex.

Obs.—There is great diversity among the few forms of Colydiidae we have examined.

We might perhaps associate *Enarsus* and *Aulonium*, though there is much difference between them. *Enarsus* is one of the connecting links of the trilobe aedeagus with the sheath-forms (Trogositidae, etc.) that we have at present placed in Cucujoidea. We have therefore in our table also given this genus a place in Byrrhoidea. *Aulonium* is more definitely Trogositoid.

Deretaphrus is not thoroughly elucidated. There may

be an affinity with *Rhizophagus*. It is very different from the trilobe form.

Cerylon is extremely difficult. If the ring at the base of the long tubular median lobe be really the tegmen as we have assumed, the genus might be said to be a trilobe form with tegmen greatly reduced, with concomitant great development of the median lobe in the tubular form. This in fact would then be a form of development in some respects parallel with what we find in Chrysomelidae.

A thorough study of the forms at present associated in Colydiidae would probably lead to the dismemberment of the family, and would in addition throw a considerable light on Coleopterous taxonomy.

Family CUCUJIDAE.

Forms examined: *Passandra fasciata* Gray, Central America. *Hectarthrum cylindricum* Sm., Queensland. *Cucujus mniszcechi* Grouv., Japan. *Brontopriscus pleuralis* and *B. sinuatus* Sharp, New Zealand. *Brontes lucius* Pasc., Queensland. *Diagrypnodes wakefieldi* Wat., New Zealand. *Chaetosoma scaritides* Westw. (?), New Zealand. *Rhizophagus depressus* Fabr., England.

Figs. 96-101 Pl. LVIII relate to these forms.

Passandra fasciata (Pl. LVIII figs. 96, 96a).

Median lobe short and fairly broad, with the median orifice at tip, on dorsal aspect; the basal dorsal edge is continued as a broad strut (*a*), which suddenly narrows and continues as a long fine strut (*b*). The tegmen forms a ring, the dorsal side is formed by a pair of long lateral lobes, wide at their base, where they are consolidated together into a plate, and narrow for the distal three-fourths where they are free; the ventral portion of the ring is formed by a broad plate attached to the outer basal corners of the lateral lobes. Internal sac very long and narrow, except at its base where it is complex; the basal complex part of the sac evaginates easily and then forms a cross-shape body (fig. 96a); the distal portion (*c*) has the opening at its apex and forms a semi-chitinous trough; the lateral portions (*d*) are semi-chitinous; two small diverticula (*e*) turn basally, and basad of these are two more that bear hairs. The rest of the long internal sac is narrow. At the apex of the sac there is a semi-chitinous tongue (*f*) through which the ejaculatory duct passes. The enlarged part of the ejaculatory duct forms a chitinous tube. It is possible that this part of the duct passes through to apex of the sac and forms a flagellum.

Hectarthrum cylindricum

is on a similar plan, but the consolidated basal part of the lateral lobes is constricted off from the free portion and forms a distinct plate.

From certain specimens that we have examined it appears probable that the chitinous ejaculatory duct forms a flagellum, and is capable of being thrust right through the tongue at apex, and entirely up the internal sac.

This type (*Passandra* and *Hectarthrum*) differs from the rest of the Cucujidae we have examined in having a large plate on the ventral side of the ring-piece instead of the consolidated tegminal struts (*tg*).

Cucujus mniszewski (Pl. LVIII fig. 97).

Median lobe well developed, cylindrical, slightly flattened laterally ; median orifice on dorsal aspect near apex, the ventral edge continued into a small point ; dorsal basal edge continued into large median strut (*ms*). Tegmen forming slender ring-piece, with small cap-piece, bearing small lateral lobes. Internal sac very long, with long, slender flagellum arising from the apex, at the tip of which the ejaculatory duct opens.

Brontopriscus sinuatus (Pl. LVIII fig. 100).

Median lobe small, tubular, with median orifice at tip, the basal part continued as a large flat strut, narrowing in middle and spatulate at the end (*a*). Tegmen consisting of a ring piece with dorsal cap, the cap being formed by a curved plate produced into two flattish lateral lobes ; there is no line of division between the plate and the lateral lobes. Internal sac very long, with a long fine flagellum rising from the apex ; about the middle the sac is swollen and its surface studded with fine, short spikes.

In *Brontopriscus pleuralis* the aedeagus is very similar, but the flagellum is longer, and there are four broad, short spines on the sac about a third from its base.

Brontes lucius is very near to *Brontopriscus*, but the median strut is longer and more slender ; the middle of the internal sac slightly dilated and covered with long strong hairs and the rest of the sac sparsely covered with stout hairs.

Diagrypnodes wakefieldi (Pl. LVIII figs. 99, 99a).

Median lobe slender, curved and membranous, with a thin chitin-rod on each side to support it ; median orifice on ventral aspect near tip. The tegmen forms on dorsal aspect a large cap, which is

formed by two pieces articulated together, the distal one bearing two small lateral lobes. It is possible that the distal piece is the basal part of the lateral lobes, and the basal plate is the basal piece. The basal corners of this basal plate meet under the median lobe. No differentiated internal sac.

Chaetosoma scaritides (Pl. LVIII fig. 98).

Median lobe slender, chitinous on ventral aspect, membranous on dorsal; median orifice on dorsal aspect of tip, ventral edge pointed and projecting beyond dorsal edge. Tegmen forming a ring, with large dorsal cap-piece formed of a large curved plate with a pair of broad lateral lobes at apex; the ring is broad and continued as a strut (*tg*) on ventral side. Internal sac small, not differentiated.

There are probably more than one species of *Chaetosoma* in New Zealand, and if so the one here dealt with is not the *C. scaritides* of Westw. Ours is a comparatively large, black form, found by Commander J. J. Walker at Wellington.

Rhizophagus depressus (Pl. LVIII fig. 101).

Median lobe large, tubular and slightly curved; median orifice at apex, the base prolonged into a long dorsal strut. Tegmen forming a slender ring round the median lobe, the dorsal part slightly enlarged into a very small cap-piece. Internal sac large, with stout, twisted flagellum arising from apex.

This differs from Nitidulidae by the large, exposed median lobe, the cap-piece of the tegmen reduced so as not to cover the lobe.

This family is of great interest and requires much greater investigation than we have given it before any definite conclusions can be arrived at. It will eventually have to be divided. Whether or not certain divisions that have already been proposed are adequate we cannot say. *Chaetosoma* is of interest as it shows a probable transition from the sheath type (Trogositidae) to the true ring type. In *Diagrypnodes* we have a type nearer to Pythidae than to *Cucujus*. The degree of differentiation of the sac and the condition of the lateral lobes must be considered in adjusting the relationships in this family. Thus *Hectarthrum* has a more generalised tegmen than *Rhizophagus* wherein its reduction to a mere ring is very

considerable. There are several other Cucujus-forms (*Prostomis*, etc.) that we have not been able to examine, although they are probably taxonomically important.

Family HELOTIDAE.

Form examined: *Helota gemmata* Gorh., Japan, and a second species from Assam.

Figs. 106, 106*a* and 106*b* Pl. LX.

Helota gemmata (Pl. LX figs. 106, 106*a*, 106*b*).

Median lobe broad, flattened; the ventral face forming a plate of which the lateral edges project slightly; the base prolonged into two broad struts; median orifice at distal end. The tegmen formed of a large "cap-piece" on the dorsal aspect and a Y-piece on the ventral. The edges of the cap-piece are turned in and form a groove in which the projecting edges of the median lobe run. Internal sac large with complex armature at apex. This armature (fig. 106*b*) consists of a stout chitinous block (*a*), on the end of which the ejaculatory duct opens; the ventral face of this piece forms a shallowly curved plate (*b*), on the dorsal aspect are two curved plates, both deeply cleft at the tips (*c*).

This type must be placed somewhere near the Nitiulidae. It is an instance—and far from a solitary one—of an aedeagus within an aedeagus.

Family OMMADIDAE.

Form examined: *Omma stanleyi* Newm., Australia.

Omma stanleyi (Pl. LIX figs. 102, 102*a*).

Median lobe well developed, tubular with median orifice on the smaller distal end and the median foramen at the larger basal end; two short median struts; point of articulation on dorsal face. Lateral lobes large, concave on the inner surface, where this envelops the median lobe to near its tip, the basal part of the lateral lobes consolidated together. No defined basal-piece. The internal sac is simple and of medium size.

In this species the anus opens at the end of a chitinous tube (*a*) which either represents the last segment (tergite and sternite) or a chitinisation of the rectum, more probably the former.

Family CUPEDIDAE.

Form examined: *Cupes clathratus* Motsch., Japan.

Figs. 103, 103a, 104, 104a, 104b Pl. LIX.

Cupes clathratus (Pl. LIX figs. 103, 103a, 104, 104a, 104b).

Median lobe small with median orifice on ventral aspect, forming a longitudinal opening along the distal two-thirds. Tegmen complex without distinct division between the basal-piece and lateral lobes. On the dorsal side there is a plate (*a*) bilobed at tip, which covers the median lobe. A pair of large lateral lobes with complex tips, and from near their bases, on the ventral face, two long, slender spines (*b*) are given off. Internal sac undifferentiated.

There is a unique structure pertaining to the dorsal plate of the last visible abdominal segment (104, 104a, 104b). As in *Omma* the anus opens at the end of a chitinous tube (*c*), from below it there rises a pair of flattened chitinous processes (*d*). The last visible dorsal plate is deeply cleft at its distal margin, its basal part continues into the abdomen, curves under and ends in a point, a hole (*e*) being left just before the bend, through which the gut passes.

Obs.—As regards *Omma* and *Cupes*; though very peculiar they are by no means closely allied, and form two families more naturally than a single one. It is by no means impossible that the peculiarities of these two Coleoptera are indications of an old relationship with Insects of another Order (perhaps something that preceded the existing Sialidae). We really, however, know very little about the creatures and generalisation is premature. We find that their wings even have been but imperfectly studied.

Family CRYPTOPHAGIDAE.

Form examined: *Anthrophagus nigricornis* Fabr., England.

Fig. 105 Pl. LIX.

A. nigricornis (Pl. LIX fig. 105).

Median lobe short and broad, the dorsal basal edge being continued as a broad, long, strut (*a*); median orifice forming a dorso-lateral slit across the apex. Tegmen forming a ring with a large dorsal cap; the cap formed of a pair of broad, triangular lateral lobes

and a basal plate with the basal angles produced into struts (*b*) which embrace the side, but are not consolidated together on the ventral aspect, of the median lobe. Internal sac long (the apex broken and not examined).

This type approaches the Phalacridae and also the Erotylidae.

Family EROTYLIDAE.

Forms examined: *Megalodacne* sp., New Guinea; *M. grandis* Fabr., Natal. *Cypherotylus onagga* var. Lac., S. America. *Cryptodacne vittata* Broun, New Zealand. *Camptocarpus prolongatus* Crotch, Chiriqui. *Doubledaya* sp., Siam.

Figs. 107 and 108, and 108*a* Pl. LX.

Megalodacne sp., New Guinea.

Has a tubular, curved median lobe, a very large cap-piece bearing very small lobes. Internal sac more than twice as long as the median lobe with chitinous flagellum half as long as sac.

Megalodacne grandis, Natal, is similar to the above but with internal sac only a little longer than median lobe and flagellum nearly as long as the sac.

Cryptodacne vittata (Pl. LX figs. 108, 108*a*).

Median lobe short, wide and slightly flattened; median orifice at tip; median foramen large, at base, with long strut from the dorsal edge of median foramen. Tegmen forming a ring, with large cap on dorsal aspect from the apex of which rise two short lobes. Internal sac large with armature at apex; this armature consists of a curved process, chitinous on ventral and membranous on dorsal (*b*) aspect, with the opening at the tip; dorsal of this process is another consisting of a brush-like organ (*c*).

Camptocarpus prolongatus (Pl. LX fig. 107).

Median lobe long, thin, tubular, and curved near the base; median orifice at apex, the ventral edge produced into a point; median foramen at base; from the dorsal edge of the median foramen proceeds a long strut (*ms*) bifurcate at end. Internal sac long with a chitinous flagellum rising from apex nearly half as long as the sac.

Doubledaya, sp. ? (Siam) has the terminal lobes of the cap short (shorter than in *Cryptodacne vittata*, fig. 108) but the cap itself is rather longer. Internal sac not examined.

Family DISCOLOMIDAE.

Form examined: *Notiophygus* sp. (not named in Brit. Mus.), S. Africa.

Notiophygus aff. *nigropunctati* (Pl. LX figs. 109, 109a).

Median lobe strong and strongly chitinated, forming a short tube with the ventral edge of the median orifice pointed and projecting long beyond the dorsal edge, the median foramen occupying a basal ventral position with its ventral edge produced into a strong process (*pu*) by which it is articulated to the tegmen. Tegmen forming a strongly chitinated cap-piece, enveloping the median lobe, which plays through an orifice on the ventral face, the distal edge of this orifice is beset with stout short hairs (*a*). Internal sac well developed, with two small plates (*b*) as armature.

The best position we can suggest for this form at present is near to Nitidulidae or Monotomidae, but if there is any relation it is a very distant one.

Family COCCINELLIDAE.

Forms examined: *Lasia globosa* Schn.; *Mysia oblongoguttata* L.; *Coccidula rufa*, Herbst.; all abundant European forms. Also *Leis 22-maculata* F., S. Africa.

Figs. 111, 112 Pl. LXI.

Lasia globosa (= *Subcoccinella 24-punctata*, recently) (Pl. LXI fig. 111).

Median lobe in form of a long, curved, chitinous tube, with the median orifice at apex, the lip of which is turned back on the dorsal aspect and likewise projects as a thick spine on the ventral face; median foramen at base, where the tube is flattish and expanded laterally. Tegmen forming a ring round the median lobe, the dorsal part consisting of two large lateral lobes, between which is a large curved sclerite, pointed at apex and fastened at each basal corner to the large strut on the ventral face. This strut is thick and expanded at its end, and fits into the expanded end of the median lobe (*b* and *c*) to which it is attached by muscles. Internal sac undifferentiated.

Mysia oblongoguttata (Pl. LXI fig. 112).

The median lobe is very long, thin and curved, the first connecting membrane is also very long and allows the median lobe to be

withdrawn into the body cavity. The tegmen is similar to *Lasia*, but more slender, the strut being fastened at its end to the expanded base of the median lobe. Internal sac undifferentiated and opening at apex of median lobe.

In *Coccidula rufa* the median lobe is also very thin and long and withdrawn into the abdomen.

In *Leis 22-maculata* the median lobe is shorter and thicker than in *M. oblongo-guttata* and *Coccidula*, but not so stout as in *Lasia*.

This interpretation differs from Verhoeff's. He considers our median lobe as a siphon (equal to our flagellum in *Camptocarpus* and many other forms), and a part of our tegmen (*a*) as the penis, or median lobe. *Lasia globosa* supports our view. But even if Verhoeff's interpretation should prove to be correct it would not justify the placing of this family apart from all other Coleoptera; the "siphon" would merely be a structure analogous with our flagellum in so many families.

Weise has given some figures of the aedeagus of Coccinellidae (Deutsche ent. Zeitschr. 1896 Taf. i p. 368). According to our observations there is a duct within the part he figures as being the duct.

From observation of the copula of two or three species of Coccinellidae we find that the lateral lobes occupy a purely external position on the venter of the female.

Family ENDOMYCHIDAE.

Forms examined: *Endomychus coccineus* L., England. *Eumorphus* aff. *profani* (Brit. Mus. Coll.) and *E.* aff. *tetraspiloti* Hope, both from Borneo. Also *Trochoideus desjardinsi* Guér., Malay Arch., which is usually, though we think erroneously, placed in *Endomychidae*.

Figs. 113, 114, Pl. LXI; 185, 185*a*, Pl. LXX. And *Trochoideus*, figs. 184, 184*a*, Pl. LXX.

Endomychus coccineus (Pl. LXX fig. 185).

Median lobe well chitinated, tubular, curved and slightly twisted laterally, the ventral edge of the lobe projecting far beyond the dorsal edge, thus making the median orifice on the dorsal face at apex. Internal sac short, the basal part generally protruding through the orifice, with a stout flagellum arising (*fg*) from the apex. Tegmen in form of a small cap-piece (*a*) on dorsal aspect of median lobe, with a broad irregular strut (*b*) on ventral face.

Eumorphus, sp. aff. *profani* (Pl. LXI fig. 113).

Median lobe a strongly chitinised, irregular tube with the median orifice at apex and the median foramen at base. On the ventral face of median orifice project two large spines, the smaller one nearer the orifice; the orifice is closed by the folding over of a part of the side of the internal sac. Tegmen consists of an irregular, chitinous ring-piece in which there is no division between basal-piece and lateral lobes. Internal sac complex, consisting of a large bilobed process at the base of the sac, bearing several tufts of short, stout hairs, and a small, tubular, invaginate portion, also bearing stout hairs.

In *Eumorphus*, sp. aff. *tetraspiloti*, the process (a) is trilobed and is shown expanded in fig. 114 Pl. LXI, the tubular portion (c) being still invaginated and the armature at apex (b) is membranous. In this species there is only one spine on median lobe, but the projection of the lip is subspinose.

Trochoideus desjardinsii (Pl. LXX figs. 184, 184a).

Median lobetubular with median orifice at apex and median foramen at base, the ventral edge of the median orifice projecting beyond the dorsal edge; a deep constriction about one-third from the base. Internal sac small, armature not examined. Tegmen forming a large, nearly parallel-sided cap-piece on the dorsal aspect, the lateral edges curving dorsally, enveloping the sides of the median lobe, on the ventral face is a thin curved strut. On each side of the cap-piece, about one-third from its apex arise a bunch of curved hairs which cling together and have the appearance of being free lateral lobes.

This form does not fit in with the typical Endomychids, and should not be associated with them.

The Endomychidae, through *Endomychus coccineus*, show some affinity to such forms as *Mycetaca*, there being a tendency towards the reduction of the tegmen to an irregular ring-piece at the base of the median lobe, and to a strong chitinisation of the irregular median lobe; but there is room for much discussion as to these Endomychid forms.

Family MYCETAEIDAE.

Form examined: *Mycetaca hirta* Marsh., England. Fig. 115 Pl. LXI.

M. hirta (fig. 115).

Median lobe irregularly curved, laterally flattened and expanded at apex, where the median orifice is situate; median foramen at

base. Tegmen forming a ring-piece, the dorsal cap being broad, short and bilobed at apex, the ventral portion of the ring being produced into a strut. Internal sac undifferentiated.

This type approaches the more generalised Coccinellidae and Endomychidae.

Family LATHRIDIIDAE.

Forms examined: *Lathridius lardarius* Deg., England.
Corticaria pubescens Gyll., England.

Figs. 116 and 117 Pl. LXI.

Lathridius lardarius (Pl. LXI figs. 116, 116a).

Median lobe small with median orifice at tip and median foramen at base. Tegmen forming a large cap-piece, the distal part formed of the consolidated lateral lobes, curved and pointed. The basal-piece large, curved, and the basal corners produced into two short struts (s). Internal sac undifferentiated.

Corticaria pubescens (Pl. LXI figs. 117, 117a).

Median lobe short, with large median orifice which nearly divides it into a dorsal and a ventral plate, a median strut (*ms*) proceeds from the dorso-basal edge. Tegmen forming a small ring with a large strut (*tg*) on the ventral side. Internal sac large, covered with stout chitinous hairs.

We cannot place this type near to any other in the present defective state of our information. *Corticaria* and *Lathridius* are so distinct that they can hardly be retained in one family.

Family ADIMERIDAE.

Form examined: *Adimcrus crispatus* Sh., St. Vincent.
Fig. 118 Pl. LXII.

A. crispatus ? (fig. 118).

This is a trilobe form with well developed median lobe with median orifice at apex; lateral lobes embracing the sides of the median lobe; a large basal-piece, chitinous on ventral side. Internal sac undifferentiated. It approaches the Mycetophagidae and the *Enarsus* portion of the Colydiidae. The organ is very minute.

Family AGLYCYDERIDAE.

Forms examined: *Aglycyderes setifer* Woll., Canary Islands. *A. wollastoni* Sharp, New Zealand.

Fig. 119 Pl. LXII.

A. setifer (Pl. LXII fig. 119).

Median lobe tubular, slightly curved and twisted; median orifice at tip, the edge membranous without demarcation between it and base of internal sac; median foramen at base, the lateral edges being produced into two median struts (*ms*). Tegmen forming ring round median lobe, the dorsal part being in form of a large, nearly parallel-sided cap, blunt at apex; on the ventral face the ring is produced into a single terminal strut (*tg*). Internal sac short and with what appears to be a spine on its base (*a*).

In *A. wollastoni* the median lobe is shorter and stouter, the median orifice forming a narrow horizontal slit across apex. The tegmen is more slender at the base of the cap and the ring and ventral strut curved.

Family PROTERHINIDAE.

Forms examined: *Proterhinus validus*, *P. ferrugineus*, and *P. gigas*, Hawaiian Islands.

Fig. 120 Pl. LXII.

P. validus (Pl. LXII fig. 120).

Median lobe tubular and very slightly curved, the membrane at the median orifice extending basally nearly dividing the chitinous part into a dorsal and a ventral sclerite, the edges of the orifice produced into a dorsal and a ventral point, the ventral one being the longer and curved; median foramen at base, the lateral edges prolonged into two long median struts (*ms*). Tegmen forming a ring round the median lobe, the dorsal cap being large, nearly parallel-sided and blunt at apex. Internal sac small.

P. ferrugineus is similar to *P. validus*, but the ventral edge of the median orifice is produced into a longer and narrower point.

The families Proterhinidae and Aglycyderidae are hard to separate. In both cases there are only three joints to the tarsi, the third one having a small piece constricted off at the base, but it is not a true joint. The "beak" in the female *Proterhinus* varies in the different species and

the head of *A. setifer* and *A. wollastoni* differ. The presence of wings in *Aglycydcrus* but not in *Proterhinus* is the only distinct difference we can point to at present.

Family MYCETOPHAGIDAE.

Form examined : *Mycetophagus quadripustulatus* L., England.

Fig. 110 Pl. LX.

M. 4-pustulatus (Pl. LX fig. 110).

Median lobe large, flattened and pointed at tip, the basal angles being prolonged into a pair of median struts, median orifice at tip on ventral face. Lateral lobes large, flattened, enveloping the basal part of median lobe. Basal-piece large, chitinous on ventral face, membranous on dorsal. Internal sac undifferentiated.

Apparently a trilobe form with mobile median lobe. Cf. Dermestidae, and *Thymalus* in Trogositidae.

Family DERMESTIDAE.

Forms examined : *Dermestes murinus* L., England.
Anthrenus claviger Er., England.

Fig. 121 Pl. LXII.

D. murinus (Pl. LXII fig. 121).

A modified trilobe form, with long, slender median and lateral lobes, the median orifice near tip on ventral face, and the median foramen at base, where the edge is extended on each side into a short median strut (*ms*); the point of articulation is on the dorsal aspect. Basal-piece small, and fitting over the base of lateral and median lobes. Internal sac undifferentiated.

Anthrenus claviger.

Has a thin curved median lobe with two median struts, with broad lateral lobes, rounded at tips, much longer than the median lobe. Basal-piece somewhat as in *D. murinus*.

This is a trilobe form, and may carry with it *Ectrephes* and *Ptinus* qq. v.

Family BYRRHIDAE.

Form examined: *Byrrhus gigas* Fabr., Alps.

B. gigas.

Of the simple trilobe type. Median lobe chitinous along the dorsal aspect, the apex of which is cleft, each point flattened and slightly twisted; struts at base very short; median orifice supported by a very attenuated chitinous ring, the ventral margin prolonged into a sharp-pointed lobe, supported on the ventral face by a narrow chitin plate. Lateral lobes well developed, their bases meeting on dorsal and ventral aspects, and thus enveloping the median lobe, their apices pointed; point of articulation on the dorsal aspect. Basal-piece triangular. Internal sac undifferentiated.

This is very like *Hydrophilus*.

Family CHELONARIIDAE.

Form examined: *Chelonarium zapotense* Sharp, Guatemala, and *C. errans* Sh.

Chelonarium zapotense (Pl. LXII figs. 122, 122a).

This is a highly specialised trilobe form. Median lobe short, stout, highly chitinated; the ventral side being drawn out into two long median struts. To the ends of these struts is articulated a median process, bilobed at the base, slender in the middle and divided into two long, slender, flat, bent, distal processes (*a*). Lateral lobes small, rounded at apex and curved. Basal-piece formed by a large sclerite on the ventral aspect, with lateral and basal edges curved up; dorsal side membranous. Internal sac undifferentiated.

C. errans is exactly the same type, but some details are different (*i. e.* the slender process (*a*) from the ventral aspect is single).

Family CYATHOCERIDAE.

Form examined: *Cyathocerus horni* Sh., Central America. Figs. 123 and 123a Pl. LXII.

C. horni (Pl. XLII figs. 123, 123a).

Median lobe long, thin and crooked, with median orifice at apex and median foramen at base on dorsal aspect. Tegmen forming sheath with the distal end cleft along the dorsal aspect, but without division between lateral lobes and basal-piece. Internal sac undifferentiated.

The tegmen of this comes near to the Trogositidae, but the median lobe is quite unique so far as we have observed.

Family GEORYSSIDAE.

Form examined: *Georyssus pygmaeus* Fabr., England.
Fig. 124 Pl. LXII.

G. pygmaeus (Pl. LXII fig. 124).

Trilobe form, flattened horizontally. Median lobe flattened, pointed at tip. Lateral lobes flattened, rounded at apex, concave along the inner edge so that the median lobe can fit into the concavity, and so become nearly hidden. Basal-piece large, chitinous on ventral face, membranous on dorsal. Sac not examined.

This is a trilobe form, and reminds one of some of the Gyrinidae. It cannot be placed with *Cyathocerus*.

Family HETEROCERIDAE.

Form examined: *Heterocerus flexuosus* Steph., England.
Figs. 125 and 125a Pl. LXIII.

H. flexuosus (figs. 125, 125a).

Median lobe large, chitinous on ventral and lateral faces, membranous on dorsal, produced into short bilobe strut (*ms*) at base, the apical point slightly turned aside. The internal sac appears to be permanently everted and, when at rest, twisted up on the dorsal face of the median lobe. Tegmen forming a large cap on dorsal aspect of median lobe, produced into a broad strut at base, slightly emarginate at apex, and the lateral edges turned down and enveloping the side of the median lobe, but only connected by membrane (*m*) on the ventral aspect.

Family PARNIDAE (= Dryopidae of some).

Forms examined: *Pelonomus palpalis* Sh., Central America. *Parnus luridus* and other species, England.
Figs. 126 and 127 Pl. LXIII.

P. palpalis (Pl. LXIII fig. 126).

Median lobe long, slender and slightly curved, the median orifice on ventral aspect near tip, base articulated to base of lateral lobe on dorsal aspect (*pa*). Lateral lobes large, pointed at tips,

and slightly curved, the bases meeting on dorsal and ventral sides. Basal-piece, forming a large sclerite on ventral face, with its edges turned up along sides and base, meeting together where lateral lobes are articulated. Internal sac undifferentiated.

In the genus *Parnus* the lateral and median lobes are very small, the basal-piece large, and forming a long chitinous and slightly curved tube. The internal sac undifferentiated. Figs. 127 and 127a Pl. LXIII, are of *P. luridus*. It has a curved chitinous spine (c) on the ventral aspect of the median orifice.

Family DERODONTIDAE.

Form examined: *Laricobius erichsoni* Ros., Macugnaga.
Fig. 128 Pl. LXIII.

Laricobius erichsoni (Pl. LXIII fig. 128).

Trilobe form. Median lobe large, fairly wide, and pointed at tip, formed of a large chitinous sclerite on dorsal aspect, membranous on ventral face; median orifice on ventral aspect before tip. Lateral lobes large, round at tips, excavate at base on inner side where they envelop the base of the median lobe. Basal-piece large, formed by a shield shape sclerite on ventral aspect, emarginate at base, and membranous on dorsal face. Internal sac undifferentiated. Closely allied to *Mycetophagus* q.v.

Family CIOIDAE.

Forms examined: *Cis boleti* L. and *C. nitidus* Herbst.
England.

Figs. 129 and 129a Pl. LXIII.

Cis boleti (Pl. LXIII figs. 129, 129a).

Median lobe long, slender and tubular, with median orifice at apex. Lateral lobes of tegmen forming a large plate on the ventral aspect, turned up along the lateral edges, and the distal end flattened and slightly expanded, forming a median, emarginated process and a rounded process on each side of it; basal-piece small, chitinous on the ventral aspect. Internal sac not dissected out, but apparently not differentiated.

C. nitidus is on the same plan, but the large plate formed by the tegmen is cleft down the distal half.

The ventral aspect of the tegmen is an important feature of this family.

Family SPHINDIDAE.

Forms examined: *Sphindus dubius* Gyll., Brockenhurst.
Aspidiphorus orbiculatus Gyll., Brockenhurst.

Fig. 130 Pl. LXIII.

Aspidiphorus orbiculatus (Pl. LXIII fig. 130).

Median lobe large, cylindrical and curved, the base drawn out on dorsal face into a wide strut (*ms*), bifurcate at end; median orifice at apex on dorsal face. Tegmen forming a ring with large cap on dorsal face; cap curved and pointed at apex. Internal sac small, with armature at apex.

In *Sphindus dubius* the tegmen forms a ring with a large cap-piece; the median lobe is produced at the base on dorsal face into a wide strut, bifurcate at end. Internal sac complex at apex.

At present we can only place this form near Phalacridae, etc., but the association is a forced one.

Family BOSTRICHIDAE.

Forms examined: *Apate terebrans* Pall., Africa. *Schistoceros cornutus* Pall. (= *Bostrichus migrator* Sharp, teste Lesne), Hawaïia.

Apate terebrans (Pl. LXIII fig. 131).

Median lobe large and flattened horizontally with two struts at the base (*ms*) turned up and pointing distally; median orifice near tip on ventral aspect; membranous (*m*) at the tip on dorsal face along the sides, and ventrally along the middle, except round the median orifice. Tegmen forming a small curved plate on ventral aspect, with the distal corners produced into strong curved hooks (*a*) which grip the edges of the median lobe and act as a guide through which it moves; basally they are produced into a pair of strong struts (*s*). Internal sac undifferentiated.

Schistoceros cornutus appears to be more simple (no description has however been made of it).

Family LYCTIDAE.

Forms examined: *Lyctus canaliculatus* Fabr., England.
L. (Minthea) rugicollis Walk., Manila. *Tristaria grouvellei* Reitt., Australia.

Figs. 132 and 132a Pl. LXIII.

Lyctus canaliculatus (Pl. LXIII figs. 132, 132a).

This appears to be a trilobe form, with a long, thin median lobe pointed at apex, and long lateral lobes, flattened laterally, the basal part of the median lobe is curved upwards and is articulated to the base of the lateral lobe. The basal-piece consists of a thin chitinous plate encircling the base of the lateral lobes, very narrow dorsally and wider ventrally. Internal sac undifferentiated.

Lyctus rugicollis.

In this the aedeagus is much shorter as regards the lateral and median lobes, but the basal-piece is longer and more pointed.

Tristaria grouvellei is quite of the same type as *Lyctus*.

Obs.—The Lyctidae forms are of great importance, as they may not improbably show an alliance with the Colydiidae group. There may even be an approximation to the Caraboidea. An examination of a larger series of Bostrichidae is required before coming to a conclusion as to these forms. At present *Lyctus* appears very different from *Apate*.

Family PTINIDAE.

Forms examined: *Ptinus fur* L., England. *Ptilinus pectinicornis* L. and *Ernobius mollis* L., England.

Figs. 133, 134 and 134a Pl. LXIV.

Ptinus fur (Pl. LXIV fig. 133).

Median lobe long, thin and curved at the base with the point of articulation on the dorsal aspect; median orifice near tip on ventral face; median foramen at base. Lateral lobes long, narrow and asymmetrical, the right one being broadened out at tip, the left one more acute, basal-piece forming a small sclerite at the base of the lateral lobes, on the ventral side, its distal margin being deeply emarginate. Internal sac undifferentiated.

This type approximates to *Lyctus*. Note the peculiar connection of the bases of the lateral and median lobes.

Ernobius mollis (Pl. LXIV figs. 134 and 134a).

Median lobe asymmetrical, curved, tubular, flattened at apex and expanded and strongly curved at base dorsally, where it articulates with the bases of the lateral lobes. Lateral lobes asymmetrical, the left one is twisted and the point acute, with a narrow base running along the edge of the basal-piece; the right one has a rounded apex with a point below the apex, on the inner side, and the base is broad.

Basal-piece curved, and, together with the basal parts of the lateral lobes, forming a bulb enveloping the base of the median lobe. Internal sac very little differentiated, without armature.

Ptilinus pectinicornis is on the same type as *Ernobius*, but the median lobe is slender and symmetrical and has a slender rod-like piece arising from the base and along the dorsal face (as if there were two median lobes). Lateral lobes also slender and more symmetrical. Basal-piece forming, with the bases of the lateral lobes, a bulb which covers the base of the median lobe. Along the ventral side of the aedeagus lies a narrow sclerite, bilobed at tip; this appears to pertain to the body segments, and arises from the membrane connecting the aedeagus to the chitinous body wall (second connecting membrane).

These two are greatly modified trilobe forms, and their connection with such a form as *Ptinus fur* is easily conceivable.

Family ECTREPHIDAE.

Form examined: *Polyplocotes longicollis* Westw., Australia.

Fig. 135 Pl. LXIV.

This is a trilobe form. Median lobe long, slender and tubular; median orifice near apex; median foramen at base, where the edge turns up dorsally and articulates to base of lateral lobes. Lateral lobes long and thin, the rounded tips bearing hairs; the bases of the lobes touch both dorsally and ventrally; the inner side excavated and enveloping the base of the median lobe. Basal-piece small, forming a ring round the bases of the lateral and median lobes, the ring being widest on the ventral face. Internal sac undifferentiated.

This type approaches the *Dermestidac*; but note the intimate connection of the sclerites basally at one point.

Family MALACODERMIDAE. (s. l.).

Forms examined: *Dictyopterus* (or *Eros*) *aurora* Herbst., Scotland. *Lycostomus gestroi* Bourg., Sarawak.? *Metriorrhynchus thoracicus* F., New Guinea. *Cratomorphus diaphanus* F., Brazil. *Lampyris noctiluca* L., England. *Luciola vespertina* F., Pusa. *Phaenolis ochraceus* Gorrh., Centr. America. *Drilus flavescens* Geoffr., England. Gen. n.? aff. *Chauliognathus*, New Guinea. *Silis ruficollis* Fabr., England. *Telephorus nigricans* Müll., *T. (Rhagonycha) limbatus* Th., and *testaceus* L., England. *Malachius bipus-*

tulatus L., England. *Anthocomus sanguinolentus* Fabr., England. *Balanophorus mastersi* Macl., Australia. *Danacaea denticollis* Baudi, Piedmont. *Melyris abdominalis* F., Africa. *Henicopus armatus*? Lucas, Reynosa. *Psilothrix cyaneus* Ol., England. *Astylus fasciatus* Germ., Brazil. *Phlocophilus edwardsi* Steph., England.

Figs. 136-146 Pls. LXIV and LXV, also Fig. 186 Pl. LXXI relate to these forms.

Dictyopterus aurora.

Median lobe thin, flattened laterally and curved slightly upwards, there is a small spine on the dorsal face near the base. Lateral lobes broad, nearly as long as the median lobe, consolidated together for their basal three-fourths on dorsal face. Basal-piece shorter than the lateral lobes, chitinous on the ventral aspect only; and there with a large emargination so that it articulates with the lateral lobes by two slender projections. Internal sac undifferentiated. This is a trilobe type with the lateral lobes consolidated and forming a cover on the dorsal aspect of the median lobe. The lateral lobes apparently exhibit great diversity in the Lycid division of the Malacoderms.

Lycostomus gestroi (Pl. LXIV fig. 136).

Median lobe long, thin, tubular, slightly dilated before tip; median orifice at tip, the dorsal edge prolonged as a curved spine. Lateral lobes very small, firmly attached to base of median lobe. Basal-piece comparatively small. Internal sac undifferentiated.

Metriorrhynchus thoracicus (or an allied species) (Pl. LXXI fig. 186).

Median lobe long and slender, consisting of a narrow chitinous sclerite on the dorsal face, widened slightly on the distal half and coming to a blunt point, the sides slightly curved downward; membranous on the ventral face. Median orifice on the ventral aspect near apex. Internal sac large and complex, stiffened by a narrow chitinous sclerite (α) along one side and bearing several large spines; this sac is only partly invaginated in repose, the greater part being folded under and held flat against the ventral face of the median lobe. Lateral lobes forming two large globular and membranous pads with a comparatively small basal-piece.

Cratomorphus diaphanus (Pl. LXIV fig. 137).

Median lobe large, complex; chitinous on the dorsal aspect and along the distal half, developed into a flange (α) on each side; the

basal part is turned up at a right angle (*b*), and articulated to the base of the lateral lobes (*pa*); the ventral face is membranous. Lateral lobes large, subtriangular, with a constriction dividing the apical third off from the rest; their base meeting on dorsal aspect at point of articulation; there is a short spine (*c*) on the inner side of each of the lateral lobes. Basal-piece forming an asymmetrical ring-like sclerite, the sides of which do not meet on the dorsal aspect. Internal sac undifferentiated.

Lampyris noctiluca.

This is the same type as *Cratomorphus* and very similar to it in details.

Luciola vespertina.

In this the lateral lobes are consolidated to near their tips on the dorsal aspect; the basal-piece is symmetrical, of the *Lampyris* type; median lobe slightly bulbous at base. This comes somewhat near to *Drilus*, though more complex and specialised.

Phaenolis ochraceus.

This is the same type as *Cratomorphus*, but the flanges near the apex of the median lobe are not so large, and the bent basal part is shorter; the lateral lobes are smaller, truncate, and have no constricted apical portion; the basal-piece is more slender and more asymmetrical. Internal sac undifferentiated.

Drilus flavescens (Pl. LXIV fig. 138).

Median lobe well developed; the dorsal face chitinous, apex bluntly pointed; a little before the apex there is a broad spine directed basally (*b*); base broader where it is articulated to the lateral lobes; the whole organ, basally of the spine *b*, evenly curved; ventral face membranous, supported by a thin chitin strip along its whole length. Lateral lobes broad and truncate, consolidated together at their base on the dorsal aspect, widely apart on the ventral face. Basal-piece forming a wide chitinous piece extending from one lateral lobe to the other, the central part of the ventral face being membranous (*m*). Internal sac undifferentiated.

This is comparatively a very simple form, departing but little from the general trilobe type. In our figure (138) the lines marking the incision between the lateral lobes should extend further forwards, so as to indicate the point of articulation shown in 138*a*.

Chauliognathus? (Pl. LXIV fig. 139).

The median lobe formed of a chitinous plate on the dorsal aspect and membranous on the ventral, slightly curved. The tegmen consists of two asymmetrical curved, pointed lateral lobes, and a small basal-piece connecting them. Internal sac a simple dilatation of the ejaculatory duct.

The undifferentiated sac separates this from the other *Telephorus* forms; in this, as well as in the form of the aedeagus it reminds us of Lampyrid forms. There is nothing like this insect in the British Museum Collection. It is quite *Telephorus*-like in shape, but has a large, ivory-like area on the pronotum, reminding one of the pallid spaces of the luminous organs of *Lampyridae*, etc., but we have no reason for supposing it to be luminous.

Silis ruficollis (Pl. LXIV fig. 140).

Median lobe short, wide, somewhat cone-shaped, broader at the distal than at the basal end. Tegmen complex, being in the form of a shallow cup-like piece produced on dorsal aspect as two broad, truncate lobes (*ll*) which appear to represent the lateral lobes, and the dorsal edge prolonged as a ridge (*a*). Internal sac large and complex, with two diverticula at base on dorsal aspect studded with minute spines, and with long chitinous spines at apex. The basal part of the sac is not invaginated, only the apical portion.

Telephorus (Rhagonycha) limbatus (Pl. LXV fig. 141, 141a).

Median lobe well developed, bulbous in form, with the median orifice at distal end and a small median foramen at base. The tegmen is of a complex nature and forms a complete cover for the median lobe. There is a well developed basal-piece (*bp*) with two large, truncate lateral lobes, meeting together on the ventral aspect (*ll*); on the dorsal aspect is a large plate (*a*) projecting as a bilobed piece a little beyond the median lobe; this appears to be a development of the lateral lobes. The lateral edges of this plate are consolidated to the latero-dorsal portion of the median lobe; on each side is a second lobe which is connected with the dorsal plate (*a*) at its base. The median lobe thus has no movement apart from the tegmen. Internal sac large and complex.

Telephorus (Rhagonycha) testaceus belongs to the same type as *T. limbatus*.

Telephorus (Rhagonycha) fulva (Pl. LXXVIII figs. 237, 237a).

These two figures are intended to give an idea of the internal sac of the male, and its relation to the female parts during copula. A portion of the sac (*a*) bears small spines. *ut.* wall of female passage ; *od.* oviduct.

Telephorus nigricans.

Of the type of *T. limbatus*. Median lobe slightly bulbous at base. Tegmen, forming a cover for median lobe, consisting of a plate slightly emarginate at the distal edge, with a pair of side lobes which are narrow ; this appears to be formed by the lateral lobes and a well developed basal-piece. Internal sac large and complex.

Fig. 236 Pl. LXXVIII, was made to show the relations of the parts of the sexes in *Telephorus* during copula, and was probably made from this species, but the pair from which it was taken is unfortunately not to be found at present.

Malthinus.

Figs. 235 and 238 Pl. LXXVIII have been made to give an idea of the structures during copula. They were probably drawn from *M. flaveolus* : the pair has unfortunately been mislaid.

Malachius bipustulatus (Pl. LXV fig. 142).

Median lobe long tubular, slightly enlarged on the basal half where it is membranous on the ventral face. Tegmen consisting of a cap-piece on the dorsal face, the basal angles meeting together beneath the median lobe ; the central part of the cap-piece (*m*) is membranous. The tegmen thus forms a ring-piece through which the median lobe passes. Internal sac not examined.

Anthocomus sanguinolentus is the same type as *M. bipustulatus*.

Balanophorus mastersi (Pl. LXV fig. 143).

This is a most abnormal type in which the tegmen appears to be reduced to a minimum ; at present we cannot connect it with any other Malacoderm.

Median lobe large, the distal part tubular, the basal part bulbous. The dorsal and ventral faces are chitinous, with large membrane (*m*) between : the median orifice is at the distal end, and the median foramen small and situate on the ventral face of the basal end. The tegmen consists of a pair of very small lateral lobes situate on the ventral face of the median foramen. Internal sac large.

This perhaps functions in the same manner as so many Staphylinids in which the median lobe is bulbous; but we have only one specimen, and another examination of this and allied forms is desirable. A specimen of another brachelytrous Malacoderm from Larat (*Helcogaster*?) indicates that this form may prove to be connected with Telephorinae.

Danacaea denticollis (Pl. LXV fig. 145).

Median lobe tubular and curved; the median orifice at apex, its dorsal edge being drawn out into a point far beyond the ventral edge; median foramen at base, its ventral margin being emarginate, forming a cavity into which the base of the tegmen fits. Tegmen forming a "ring-piece," the dorsal part forming a small, truncate lobe or cap (the lateral lobes) bearing a few hairs; a thin strip proceeds from each basal angle of the cap-piece and the two strips meet together on the ventral side of the median lobe, thus forming a ring round the median lobe. The ventral (or basal) part of the ring-piece is raised into a knob which fits into the emargination at the base of the median lobe and is attached thereto by muscles, and the median lobe turns upon it when it is moved through the ring-piece. Internal sac large and complex.

Melyris abdominalis.

Median lobe tubular and slightly curved; the median orifice is at the distal end and extends some way along the tube as a narrow slit; median foramen at base. Tegmen forming a ring-piece, the cap being very slightly emarginate at tip and bearing a few long hairs. Internal sac large and complex.

Henicopus armatus?

Median lobe short, tubular, the basal part slightly enlarged, emarginate on dorsal face of median foramen where the tegmen is attached. The median orifice at distal end, the ventral edge produced into a point beyond the dorsal edge. Tegmen forming a strong ring-piece, the cap produced into two short lobes bearing hairs. Internal sac large, studded with long, strong, chitinous spines.

Psilothrix cyaneus (Pl. LXV fig. 146).

Is of the same type as *Henicopus*, the median lobe being thick, and produced into a short point on the ventral edge of the median orifice, the cap of the ring-piece is slightly bilobed. Internal sac large, studded with short chitinous spines.

Astylus fasciatus.

Has a long, slender, tubular median lobe, dilated at base where

the tegmen is attached, the ventral edge of median orifice produced into a point. Tegmen long and narrow, the cap-piece being long and narrow, bilobed at tip. Internal sac long.

Phlocophilus edwardsi (Pl. XLV fig. 144).

Median lobe long, thin, slightly flattened, with two short median struts. Tegmen forming a ring with a large, flattish plate, extending basally on the dorsal side (*a*). This is an abnormal type and at present we cannot fit it in to any of the Malacoderm group.

The Malacodermidae consist certainly of more than one family, but as our review of them does not enable us to speak of the number or composition of the families, we have used the old, vague term. Some additional remarks on the subject will be found under the heading "Taxonomy."

Family CLERIDAE.

Forms examined: *Natalis porcata* Fabr., Australia. *Trogodendron fasciculatum* Schr., Australia. *Cylidrus* sp., New Guinea.

Figs. 147, 148 and 148*a* Pls. LXV and LXXVI.

Natalis porcata (Pl. LXV fig. 147).

Median lobe long, slender and membranous, supported by a chitinous strip down each side. These are prolonged into a pair of median struts. Tegmen sheath-shape, the division between lateral lobes and basal-piece obliterated. Internal sac undifferentiated.

Cylidrus sp., New Guinea.

Median lobe short, prolonged into a pair of long median struts. Tegmen sheath-shape without division between lateral lobes and basal-piece. Internal sac undifferentiated.

Trogodendron fasciculatum (Pl. LXVI figs. 148 and 148*a*).

Median lobe well developed, the median orifice at tip on ventral face; a pair of median struts expanded at their ends. Tegmen large and forming a sheath, deeply cleft on dorsal, and slightly on ventral face, but no line of demarcation between lateral lobes and basal-piece. Internal sac undifferentiated.

This type approaches Trogositidae.

Family LYMEXYLONIDAE.

Forms examined: *Atractocerus valdiviensis*? Ph., Chile.
A. africanus Boh., Madagascar.

Figs. 149 and 150 Pl. LXVI.

Atractocerus valdiviensis? (Pl. LXVI fig. 149).

Median lobe short and bulbous, drawn out to a short point at apex where the median orifice is situate, base produced into two short median struts; median foramen at base. Tegmen forming a shallow concavity in which the median lobe rests, and consisting of two sclerites; a distal bilobed (lateral lobes) piece, with two struts encircling the median lobe and a curved basal-piece connected to the lateral lobes by a membrane (*cm* 1). The internal sac appears to be simple, which is exceptional when the median lobe is bulbous.

We speak with much hesitation as to this and the following owing to the bad preservation of the two individuals. The specimens of this genus are too often found to be in a disastrous state in collections.

Atractocerus africanus (Pl. LXVI, figs. 150, 150*a*).

Median lobe long and slender with orifice at apex and foramen at base. Lateral lobes complex, forming a pair of large complex lobes joined together on the ventral aspect where they form a medial square plate (*a*) deeply emarginate in the middle, and on the dorsal face continue as two flat sclerites which join together at their bases where the median lobes articulate (*pa*). The basal-piece forms a large shield-shaped plate on the ventral face, the distal corners prolonged into a pair of obtusely rounded projections. Internal sac undifferentiated.

The anus of this species opens at the end of a large tube, which lies over the aedeagus.

These two types differ from one another and do not approach to any of the other trilobe forms. We anticipate that they will prove to be of important bearing.

Family DASCILLIDAE.

Forms examined: *Ptilodactyla* sp., Brazil. *Dascillus cervinus* L., England.

Figs. 151 and 152 Pl. LXVI.

Ptilodactyla (not named in Brit. Mus.) (Pl. LXVI fig. 151).

A trilobe form. Median lobe well developed, tapering to a fine point at apex; median orifice on ventral aspect, forming a long slit

along the basal half; two well developed median struts. Lateral lobes large, meeting at their bases both ventrally and dorsally, excavate on inner side so that they envelop the median lobe (in figure they are shown apart so as to expose the median lobe). Basal-piece large shield-shape, membranous on the dorsal aspect. Internal sac undifferentiated.

Dascillus cervinus (Pl. LXVI fig. 152).

Median lobe complex, consisting of two parts; dorsally a large flat sclerite, bluntly rounded at tip with the sides turned down (*a*), with two short struts at base; ventrally a smaller sclerite pointed and curved downward at tip (*b*) with a pair of basal struts and a strong raised piece in the centre at base (*c*); the ejaculatory duct opens at the base of these two sclerites. Lateral lobes large, curved, nearly meeting at their bases on ventral aspect, where they are articulated to the central raised piece (*c*) of the median lobe, but somewhat apart on the dorsal aspect, where they are articulated to the edges of the dorsal plate (*a*) near its base. Basal-piece well developed on the ventral aspect. Internal sac undifferentiated. When the median lobe is thrust forward during copulation the lateral lobes open laterally, the dorsal plate of the median lobe turns up dorsally, and the ventral piece turns ventrally, the median orifice then lies at the bottom of these organs.

The Dascillid male is a trilobe type and at present we cannot connect it with the Malacodermidae further than by the approximation that occurs in simple forms (cf. *Drilus* and *Dictyopterus*).

Family CYPHONIDAE.

Forms examined: *Microcara* (or *Helodes*) *livida* Fabr., England. *Cyphon coarctatus* Payk., England.

Figs. 187 and 188 Pl. LXXI.

Microcara livida (Pl. LXXI fig. 187).

When the aedeagus is extended there are nine distinct tergites, the anus lying below the ninth tergite; the first two sternites are obscure and lie beneath the last coxae, the third being the first visible segment; the eighth and ninth are distinct. The aedeagus comprises all the structures that lie between the anus and the ninth sternite. Basally the aedeagus consists of a large bilobed plate on the dorsal side, continued on the ventral side as a membrane (the tegmen) (*tg*); this ensheathes the median portion, which consists of a trilobed body,

two lobes having dorso-lateral positions and the third a ventro-median one, this lobe is continued as a narrow, thin plate having a narrow edge of chitin; the end of the ejaculatory duct (or undifferentiated internal sac) lies on this plate and has a wide opening on a membrane between the two dorso-lateral lobes.

This median portion we consider is the median lobe. In certain of the Dascillidae (i. e. *Dascillus cervinus*) the median lobe is represented by a pair of processes rising from the edge of the median orifice. The tegminal fold is quite distinct, separating the median or distal portion from the basal and outer portion, and it is highly probable that it is homologous to the same fold in other types.

Cyphon coarctatus (Pl. LXXI fig. 188).

When the aedeagus is fully drawn out the 8th and 9th abdominal segments are distinct, the tergites plain, and well chitinised with a strut from each posterior corner. The sternites not so well defined. The anus lies beneath the ninth tergite, and the structure between the anus and the ninth sternite is the aedeagus. This structure consists of a membranous tube with a very large orifice (median orifice), the opening of the ejaculatory duct or undifferentiated internal sac. On the dorsal side this tube is supported by a chitinous V or Y piece, on the ventral edge there are two curved chitinous hooks which are extended inwardly as a broad thin plate.

The homologies of this structure are difficult to make out, as owing to the absence of a distinct tegminal fold there is no guide. *Helodes* is the nearest type to which we can refer it. Considering the opening of the ejaculatory duct as homologous in these two forms then the curved hooks and plate would be equivalent to the lobes and plate of *Microcara* (*Helodes*) and the tegmen would not be represented at all. Until more Dascillid and allied forms have been studied this is the best explanation we can give, but we fully recognise its weakness.

By the structure of the undifferentiated internal sac, etc., we had considered it probable that copula did not take place in the usual manner in this form, but that it was possible that the female "ovipositor" was inserted into the large median orifice. An observation of the senior author adds strength to this supposition, but it needs more confirmation; any observations of the copulation of Dascillids, Cyphonids and their allies will be of interest, especially as to the part played by the "internal sac."

We hope that one of us may be able to elucidate this

abnormal family by the aid of some of the larger and less delicate exotic forms, of which we should be very glad to receive examples.

Family RHIPICERIDAE.

Form examined: *Callirrhapis philiberti*, Seychelles.

Fig. 153 Pl. LXVI.

Callirrhapis philiberti (figs. 153, 153a).

Median lobe large, formed by a large sclerite (*a*) on dorsal face, narrow at apex which is slightly cleft, widening towards the base, which is continued into two median struts, and a slender chitin rod (*b*) on the ventral face, the sides being membranous. Lateral lobes large, pointed at apex, and widening at base where they consolidate together on the ventral face and just touch on the dorsal. Basal-piece large membranous on dorsal aspect and in the centre of ventral aspect and with a chitinous support round the ventral. Internal sac undifferentiated, but the duct is greatly enlarged just beyond the aedeagus (*ej*).

This is an Elaterid type.

Family ELATERIDAE.

Forms examined: *Agrypnus* sp. ? New Guinea. *Anisomerus hacquarti*, Mashonaland. *Chalcolepidius albertisi* Cand., Honolulu.

Figs. 154, 155 and 156 Pls. LXVI and LXVII.

Agrypnus sp. ? (Pl. LXVI fig. 154).

Median lobe formed by a broad sclerite (*a*) on dorsal face pointed at tip, and with two struts at base, and a small chitin rod (*b*) on ventral face, the sides membranous; median orifice large, on ventral aspect near tip. Lateral lobes large, enveloping the median lobe. Basal-piece well developed, membranous on dorsal face, and in centre on ventral face (*m*) with chitin (*bp*) round the edges. Internal sac undifferentiated, with dilated duct basal to aedeagus.

Anisomerus hacquarti (Pl. LXVII figs. 155 and 155a).

Asymmetrical trilobe form. Median lobe small, with median orifice at tip and two small struts at base. Lateral lobes large, the right longer and broader than left, consolidated at their basal part into a tube. Basal-piece very small. Internal sac undifferentiated, the duct dilated basal to the aedeagus.

Chalcolepidius albertisi (Pl. LXVII fig. 156).

Median lobe slender, chitinous above and on sides, membranous on ventral face; median orifice near tip on ventral face, base produced into two long median struts. Lateral lobes a little shorter than the median lobe, flattened horizontally and deeply cleft on outer edge about half way down (*a*) nearly dividing them into two pieces; their bases meeting on the dorsal aspect. Basal-piece very long and divided into two sclerites, one long V-shape (*b*), a more basally placed piece running round the basal edge (*c*); dorsal aspect membranous. Internal sac undifferentiated.

The aedeagus in Elateridae is as a rule a generalised trilobe type, becoming compressed and asymmetrical in *Anisomerus*. The division of the lateral lobes and basal-piece into two in *Chalcolepidius* is interesting. It is a more differentiated form of the family, which seems to be on the whole rather monotonous and uninteresting.

Family THROSCIDAE.

Forms examined: *Throscus dermestoides* L., England. *Lissomus bicolor* Chevr., Mexico.

Figs. 157 and 158 Pl. LXVII.

The aedeagus of this family is a tri-lobed form near to Elateridae. In *T. dermestoides*, fig. 157, the median orifice is on the ventral aspect near to the base and the basal-piece is large and well developed. In *Lissomus bicolor* (Pl. LXVII figs. 158, 158*a*) the basal piece is membranous (*m*) in the centre on the ventral aspect, and the chitin forms a ring; the median orifice is on a membrane on the ventral aspect of the broad, flattened median lobe. The internal sac is undifferentiated.

Family EUCNEMIDAE.

Form examined: *Hemiopsida mastersi* Macl., Australia. Fig. 159 Pl. LXVII.

Median lobe short, forming a pointed, chitinous plate on the dorsal aspect, prolonged into two long median struts. Lateral lobes large, consolidated together at the base to form a tube, the distal ends spatulate and twisted. Basal-piece very small, forming a round sclerite on the ventral aspect. Fig. 159 shows the internal sac (*is*) partly protruding.

Near to the Elaterid type, but the detached, small basal-piece may prove to be distinctive.

Family BUPRESTIDAE.

Forms examined: *Euchroma goliath* Lap., Panama. *Chrysodema aurofoveata* Guér., New Guinea. *Cyphogastra* spp. ? New Guinea. *Polybothris quadricollis*, Madagascar. *Acmaodera flavofasciata* P. and M., Pyrenees. *Stigmodera macularia* Don., Australia. *Belionota walkeri* Wat., New Guinea.

Figs. 160, 161 and 161a Pl. LXVII.

Chrysodema aurofoveata (Pl. LXVII fig. 160).

The median lobe consists of a strong chitinous dorsal plate, flat, almost parallel-sided, and pointed at apex, with a deep groove (*a*) running down each side of the ventral aspect; this ventral face is membranous, with the median opening some distance from the apex, and the base prolonged into two short median struts. Tegmen strong, highly chitinised and flattened horizontally, with the lateral lobes and basal-piece consolidated into one piece. Lateral lobes consolidated for a short distance from their base on dorsal aspect, and for some distance on the ventral aspect; long, nearly parallel-sided, their rather slender tips rounded, and bearing short spines and a couple of hairs. Along the inner sides of the lateral lobes runs a chitinous projection which fits into the groove (*a*) on the median lobe and acts as a guide when this moves in and out of the tegmen. Internal sac undifferentiated.

In fig. 160 the free apices of the lateral lobes are made to appear too short and blunt, and this defect is exaggerated by the exertion of the median lobe.

Polybothris quadricollis (Pl. LXVII figs. 161 and 161a).

This is the same type as the last. Median lobe consisting of a flat dorsal plate, widest at the base and graduating to a point at apex, with a pair of median struts at base; median orifice on ventral aspect near tip. A little behind the median orifice there is a slender chitin rod attached to the ventral membrane, and projecting into the lumen of the median lobe, to which muscles are attached. Lateral lobes flattened, curving up to a point on the inner side of the apex, with basal-piece consolidated to lateral lobes. The coadaptation between lateral and median lobes is not so complete as in *Chrysodema*. Internal sac undifferentiated.

The Buprestidae differ from the Elateridae by the consolidation of the basal-piece to the lateral lobes and by the beautiful coadaptation between the lateral and median

lobes to allow of median lobe being extended beyond the tips of the lateral lobes (fig. 160); and there is no point of articulation. At present the family appears to be well isolated.

The consolidation of the lateral lobes into one piece, with the inner faces beautifully coadapted to the sides of the median lobe is found in a high state of perfection in *Euchroma*.

Family TENEBRIONIDAE.

Forms examined: *Eleodes dentipes* Esch., California. *Chiroscelis digitata* Fabr., W. Africa. *Blaps similis* Latr., England. *Zopherosis georgii* White, Australia. *Stenosis angustata* Herbst., Corsica. *Cossyphus insularis* Cast., Sicily. *Pediris* sp.? (not in Brit. Mus.) and ? *P.?* *suleigera* Boisd., New Guinea.

Figs. 162–170 Pl. LXVIII and LXIX, relate to Tenebrionidae; fig. 164 being that of a female structure observed in *Eleodes dentipes*.

Eleodes dentipes (Pl. LXVIII figs. 163, 163a).

Median lobe short with two large median struts; median orifice forming a longitudinal slit from apex to middle on the dorsal face. Lateral lobes consolidated together along their dorsal edges and forming a triangular plate with its edges turned under. Basal-piece forming a large sclerite on dorsal aspect, pointed at the base. Internal sac undifferentiated.

There is a structure in the female which is at present unique as far as our knowledge goes (fig. 164). The basal part of the oviduct is greatly dilated (*a*), a duct (*b*) which we take to be the duct of the spermatheca enters this dilatation and continues as a free coiled chitinous tube (*c*) which reaches the vulvular opening.

Blaisdell has described and figured both male and female organs of many of the American Eleodiini (Smithsonian Inst. U.S.N.M. Bull. 63, 1909).

Chiroscelis digitata (Pl. XVIII figs. 165, 165a).

Tegmen of the usual Tenebrionid type. Lateral lobes small, consolidated into a small triangular plate on dorsal aspect. Basal-piece large, curved, chitinous on dorsal, membranous on ventral, aspect. Median lobe small but distinct, with two median struts. Internal sac undifferentiated.

Blaps similis.

Is of the same type, the median lobe being small but distinct, the lateral lobes small, consolidated along the basal half, thus forming a triangular dorsal plate, split from the apex to half way to the base.

Cossyphus insularis (Pl. LXVIII figs. 166, 166a).

Of the usual Tenebrionid type, but the median lobe greatly reduced and forming a small membranous lobe on which the median orifice is situated. No differentiated sac.

Stenosis angustata (Pl. LXVIII fig. 167).

Median lobe well developed, with two median struts. Lateral lobes consolidated and forming a long, narrow, nearly parallel-sided ventral trough in which the median lobe lies, truncate and slightly curved at tip. Basal-piece forming a ventral trough-shaped sclerite, membranous on dorsal aspect.

The fact that the tegmen lies on the ventral aspect of the median lobe seems to differentiate this type from the former, but we here repeat that we have several times remarked as to the difficulty attending the orientation of the dorsal and ventral aspects of the aedeagus.

Zopherosis georgii (Pl. LXVIII fig. 168).

Median lobe long and narrow, chitinous at tip and along the sides, membranous along the median dorsal and ventral portions; median orifice near tip on dorsal aspect. Tegmen forming a large, nearly parallel-sided trough in which the median lobe lies, the distal half formed of the consolidated lateral lobes, truncate at tip and bearing fine hairs, the basal half formed of the basal-piece. Internal sac undifferentiated.

This type appears to come near to *Stenosis*.

Pcdiris sp. ? (Pl. LXVIII fig. 162).

Median lobe thin and pointed, the tip curved slightly downward, the median orifice on dorsal face near base. Lateral lobes long, slender, studded with small spines along the distal half with the tips spatulate. The lobes are quite free but their lateral edges touch on the dorsal face (in fig. 162 they are parted to show their freedom). Basal-piece large, forming a ventral sclerite with its lateral edges turned in, the dorsal face is membranous (*m*), there are two sclerites in the middle of the membrane (*a*) whose distal ends are articulated to the base of the lateral lobe.

In a similar species from the same region (Geelvink Bay) the

lateral lobes are short, consolidated together along their dorsal margins, and form a triangular plate in the characteristic Tenebrionid fashion.

Family RHYSOPAUSIDAE.

Form examined: ? *Rhysopaussus* sp. (not in Brit. Mus.) Australia.

Figs. 169, 169*a* Pl. LXVIII.

Tegmen of the Tenebrionid type. Lateral lobes consolidated along their dorsal edges, forming a triangular plate on the dorsal face with the lateral edges turned under. Basal-piece large, forming a large curved sclerite on the dorsal face, membranous on the ventral face. The median lobe is reduced to a mere small membrane on which the ejaculatory duct opens.

Family CISTELIDAE (Alleculidae of some).

Forms examined: *Omophlus lepturoides* Fabr., Rome. *Prostenus dejeani* Sol., Brazil. *Chromomaca* sp.? Australia. Figs. 170, 171 and 171*a* Pl. LXIX.

Omophlus lepturoides (Pl. LXIX fig. 170).

This aedeagus is of the Tenebrionid type. Lateral lobes very small, consolidated into a small dorsal plate, pointed at tip and curved. Basal-piece very long and narrow, enlarged at base, chitinous on dorsal and membranous on ventral faces. Median lobe reduced to a small membrane on which the ejaculatory duct opens, at ventral edge there is a small two-toothed chitinous lobe with two long struts (*a*). Internal sac larger than the ejaculatory duct, but not highly differentiated.

Prostenus dejeani (Pl. LXIX figs. 171, 171*a*).

A regular Tenebrionid type; the median lobe is reduced to a mere membranous tongue on which the ejaculatory duct opens.

Chromomaca sp.

Is of the Tenebrionid type. Lateral lobes small consolidated into a small dorsal plate, expanded at tip, and beset with small spines pointing basally. Basal-piece long and curved. Median lobe very small.

In many members of this family the terminal body segments are highly modified to form claspers (*vide* Biologia Centrali-Americana, Champion, Vol. IV. pt. 1 pls. 17–20. On Pl. LXXVIII figs. 234 and 234*a* we have represented the abdominal structure of *Cistela atra*.

Family LAGRIIDAE.

Forms examined: *Lagria hirta* L., England. *L. grandis* Gyll., Australia.

L. hirta.

Of the Tenebrionid type. Lateral lobes consolidated, forming a very small triangular plate. Basal-piece long, narrow and curved, enlarged at the base. Median lobe reduced to a small membranous tongue.

Family OTHNIIDAE.

Form examined: *Othnius lyncea* Pasc., Ceylon.

Figs. 172 and 172a Pl. LXIX.

O. lyncea (Pl. LXIX figs. 172, 172a).

Median lobe short, pointed, with broad, curved strut (*ms*) from the dorsal, basal edge. Lateral lobes consolidated into a large pointed cap-piece, with its lateral edges turned under. Basal-piece large and curved. We are in doubt as to the dorsal and ventral aspects.

We meet here with a departure from the Tenebrionidae. The basal-piece is not preponderant, but the lateral lobes are large, and include the median lobe as a cap-piece rather than as a sheath. The structures in our specimen are very feebly chitinised and somewhat difficult to make out. The position the family occupies in the Munich Catalogue is better than one near Tenebrionidae. *Othnius* cannot go in the trilobe forms because of the hooding of the median by the lateral lobes. So that at present it appears least ill-placed in the loosely connected complex we have called Cucujoidea.

Family AEGIALITIDAE.

Form examined: *Aegialites debilis* Mann., Vancouver.

Fig. 173 Pl. LXIX.

Median lobe long, slender, tubular and membranous, supported along each side by a chitinous rod (*a*) which widens out at the base and forms a ring round the median foramen (*b*). Tegmen forming a large dorsal cap composed of two large sclerites, the distal one (lateral lobes) broad, curved and coming to a point at apex, bearing a pair of small lobes near its base, its basal angles are produced into struts which are attached to the base of the median lobe; the

basal-piece of the cap consists of a large sclerite, broader at the base where it curves round the sides of the median lobe. Internal sac apparently elongate.

This type is near to *Pytho*.

Family MONOMMIDAE.

Forms examined: *Monomma giganteum* Guér., Angola; and sp., Penang.

Figs. 174 and 174a Pl. LXIX.

M. giganteum.

Median lobe long, thin and tubular; chitinous round the tip (*a*), with dorsal and ventral face supported by chitin strips. Internal sac undifferentiated. Lateral lobes large, joined together on the ventral aspect by a semi-chitinous connection, the tips truncate. Basal-piece half as long as the lateral lobes, forming a curved sclerite on ventral aspect. Fig. 174 is rather too broad.

M., sp. ?, Penang, is similar to *M. giganteum*.

We place this type with *Stenosis* and *Zopherosis* on account of the ventral orientation of the tegmen.

Family MELANDRYIDAE.

Forms examined: *Orchesia micans* Panz., England. *Phloeotrya rufipes* Gyll., England. *Melandrya caraboides* L., England.

Figs. 175, 176, and 177 Pl. LXIX.

Orchesia micans (Pl. LXIX fig. 175).

Median lobe long, thin, straight and membranous, supported by a chitin rod on each side, which flattens out at base and forms a pair of struts (*ms*). Tegmen consisting of a well-developed basal-piece produced to a long point in front (*a*), with a pair of long, thin lateral lobes. Internal sac undifferentiated.

Phloeotrya rufipes (Pl. LXIX fig. 176).

Median lobe very long and thin, supported along each side by a thin chitinous rod (*a*), these project at base as two struts (*ms*); median orifice at apex. Tegmen forming a short sheath, open at apical two-thirds (*b*) on ventral face, and produced into a long, narrow, parallel-sided, basal sclerite on dorsal face. Internal sac undifferentiated.

Melandrya caraboides (Pl. LXIX fig. 177).

Median lobe fairly short, membranous, supported on each side by

a chitinous rod (*a*); median orifice at apex. Tegmen forming a sheath, chitinous above and membranous below. Internal sac undifferentiated.

It is impossible to place these with any satisfaction at present. The Melandryidae appear to be a family of transition; or it may be an unnatural association.

Family PYTHIDAE

Forms examined: *Pytho depressus* L., Scotland. *Rhinosimus ruficollis* L., England.

Fig. 178 Pl. LXX.

P. depressus (Pl. LXX fig. 178).

Median lobe long, slender and tubular, with basal third slightly enlarged. Tegmen forming large dorsal cap, as in *Aegialitidae*, the apical part being long, narrow and pointed at tip, the two lobes long and slender; the basal-piece convex. Internal sac undifferentiated.

Rhinosimus ruficollis.

Is of the same type; the median lobe being membranous and supported along each side by a chitin rod, the basal-piece is longer than in *P. depressus*. This species in some points approaches nearer to *Aegialitidae*.

Family PYROCHROIDAE.

Pyrochroa pectinicornis L., Scotland.

Fig. 179 Pl. LXX.

Median lobe long, somewhat flattened, produced into two struts at base (*ms*), with median orifice on dorsal side near apex. Tegmen consisting of consolidated lateral lobes (*ll*) on ventral face, meeting together on dorsal face at base, and a well-developed basal-piece. Internal sac undifferentiated.

The ventral aspect of the tegmen induces us to place this and *Trictenotoma* near together; and we associate them, as well as various other families of the "Heteromera," with Cucujoidea.

Family ANTHICIDAE.

Form examined: *Anthicus maritimus* Lec, California (named by Leconte with a query).

Fig. 180 Pl. LXX.

A. maritimus (Pl. LXX fig. 180).

Median lobe short, tubular, continued from the dorsal basal part as a single broad strut (*ms*); median orifice at apex, the chitination on the dorsal face (*b*) continuing on to the sac, ventral edge of orifice projecting beyond dorsal. Tegmen forming a large cap-piece pointed at apex with the basal lateral edges turned in to form a groove in which the median lobe plays; from the base proceed a pair of divergent struts (*c*), consolidated at their bases. Internal sac undifferentiated.

The cap-piece without lobes and the undifferentiated internal sac induce us to place this also in Cucujoidea. The tegmen is however of peculiar form.

Family OEDEMERIDAE.

Forms examined: *Oncomera femorata* Fabr., England. *Copidita* (*Sessinia*) *punctum* Macl., Australia. *Dohrnia miranda* Newm., Australia.

Figs. 181, 182 and 183, Pl. LXX.

Oncomera femorata (Pl. LXX fig. 181).

Median lobe long, pointed and flattened laterally, bent up at the base, where the dorsal and ventral edges of the median foramen project, the ventral one being flattened out and serving for the attachment of muscles; median orifice on ventral face near tip; on each side near tip there is a stout, sharp spine. Tegmen consisting of a plate coming to two points at the distal end, and T-shape at base, the arms of the T curving up and embracing the median lobe; the first connecting membrane attaching the median lobe to the T-shape piece of tegmen. Internal sac undifferentiated.

Copidita punctum (Pl. LXX fig. 182).

This is on the same plan as *Oncomera*, but the tegmen is round at the apex with a slight indentation at its tip and two small recurved spines a little before the tip, on the dorsal aspect.

Dohrnia miranda (Pl. LXX fig. 183).

Median lobe flattened laterally and pointed at apex, the median orifice being situate on the ventral aspect far from the apex. Tegmen forming a large sheath, membranous on ventral (?) aspect and chitinous on dorsal (?). Internal sac undifferentiated. The position of the tegmen on the dorsal side of the median lobe does not agree with other Oedemeridae we have examined; but this requires more detailed investigation.

The ventral aspect of the tegmen causes us to place this family on one side along with Pyrochroidae, etc. But we must recall our remark as to the difficulty of determining this point.

If it could be established that the tegmen is composed of a modified chroitic sternite, then this type might be the most primitive of the coleopterous aedeagi.

Family MORDELLIDAE.

Forms examined: *Anaspis frontalis* L., England. *Pelccotomoides conicollis* Cast., Australia. *Tomoxia biguttata* Gyll., New Forest.

Figs. 189, 190 and 191 Pl. LXXI.

Anaspis frontalis (Pl. LXXI fig. 189).

Median lobe slender, tubular and semi-chitinous, and with median orifice at tip. Tegmen consisting of a pair of pointed lateral lobes consolidated at their base, and a narrow, long basal-piece. The tegmen lies on the dorsal aspect of the median lobe, with a membranous connection on the ventral aspect. Internal sac undifferentiated.

This aedeagus does not approach either in structure or orientation the other forms we have examined among the Mordellidae. It is possible that it would find a better place near *Anthicidae*.

Pelccotomoides conicollis (Pl. LXXI fig. 190).

Median lobe long, slender and curved, median orifice near tip on ventral face. Tegmen consisting of a large, basal sclerite (*bp*) on the ventral aspect of the median lobe, with a pair of highly modified lateral lobes, in the form of crescents. Internal sac undifferentiated.

Tomoxia biguttata (Pl. LXXI, fig. 191).

Median lobe long, thin and membranous, supported by a chitinous rod along each side, which join together about the middle and continue as a single median sclerite. Tegmen consisting of a sheath-like sclerite and a flat sclerite bearing three irregular processes, the two sclerites being connected by a membrane. Internal sac undifferentiated.

We are not satisfied with our knowledge of this family and hope it will be shortly increased. The orientation of

the tegmen causes us at present to put it, as exceptional, along with Oedemeridae.

Family RHIPIPHORIDAE.

Form examined: *Emenadia* sp. ? Australia.

Fig. 192 Pl. LXXI.

Median lobe long, slender, membranous, supported by a thin chitin rod on each side which meet together at the base. Tegmen of the Mordellid type. Internal sac undifferentiated.

This is the same type as Mordellidae (excl. *Anaspis*).

Family CANTHARIDAE = MELOIDAE.

Forms examined: *Tegrodera crosa* Lec., California. *Cissites (Horia) debyi* Fairm., Borneo. *Nemognatha* sp.*

Fig. 193 Pl. LXXI.

Horia (Cissites) debyi (Pl. LXXI fig. 193).

Median lobe large, flattened laterally, and bent nearly at right-angles one-third from base, the whole organ being pistol-shape; median orifice at apex, and median foramen occupying the ventral base of basal third. Tegmen consisting of a large "tambour" shaped basal-piece, and a single median piece, rounded at the apex, representing the lateral lobes. Internal sac undifferentiated.

Tegrodera crosa.

Median lobe tubular, flattened laterally, with the median orifice on dorsal aspect at tip and median foramen occupying the ventral aspect of the basal half; on the ventral aspect near tip are two spines, one in front of the other. Tegmen composed of a large rounded and curved basal-piece and a pair of lateral lobes consolidated at their base. Internal sac small with a strong curved spine at its base.

Nemognatha sp.

Median lobe tubular with a large median foramen occupying the ventral aspect of the basal half. Tegmen with lateral lobes consolidated to tip, which is roundly bilobed, basal-piece large. Internal sac well developed, but without armature.

* This specimen has unfortunately been lost; only the dissection now exists.

Family TRICTENOTOMIDAE.

Form examined: *Trictenotoma thomsoni* Deyr., hab. ?
Figs. 194 and 194a Pl. LXXII.

Trictenotoma thomsoni (Pl. LXXII figs. 194, 194a).

Median lobe long, thin and curved upward at the base; the apex chitinous, continued as a chitin strip along the ventral face, at the base this chitinous strip is a curved bar (*b*) which connects with the tegmen. Tegmen consisting of a well-defined basal-piece (*bp*) with a large sclerite (*a*) on the ventral aspect of the median lobe; near the base of the sclerite (*a*) arise two long thin lobes, spatulate at tips and hairy. The bars (*b*) from the median lobe are connected with the lateral basal edges of the large sclerite and form a spring which brings the median lobe back into position when the muscles are relaxed. Internal sac undifferentiated. The large sclerite may represent the lateral lobes of other forms, as it is closely connected with the basal-piece; in that case the remarkably long lobes (*ll*), are secondary differentiations, or appendages of the conjoined lateral lobes.

This is a beautifully constructed organ. It is a little like *Pytho*, but the orientation of the tegmen is reversed and in that respect approaches *Pyrochroidae*.

Family BRUCHIDAE (Lariidae of some).

Forms examined: *Bruchus rufimanus* Boh., England.
Caryoborus nucleorum Fabr., Brazil. C. sp.? (not named in Brit. Mus.), S. America.

Figs. 195, 196 and 197 Pl. LXXII.

Bruchus rufimanus (Pl. LXXII figs. 195, 195a).

Median lobe tubular, with the dorso-basal margin produced into a parallel-sided strut (*s*), the median orifice being at the apex. Tegmen forming a ring-piece with a pair of lateral lobes on the dorsal aspect and a wide strut on the ventral aspect. Internal sac large with armature at the base closing the orifice, consisting of a curved spine (*a*) on the ventral face and a chitinous plate (*b*) on the dorsal.

Caryoborus sp.? (Pl. LXXII fig. 196).

Median lobe a flattened tube, with the ventral and dorsal edges of the median orifice pointed, the ventral one produced beyond the dorsal one, thus giving the orifice a slit-like shape on the dorsal face; the dorso-basal edge is produced into a single dorsal strut,

chitinous on the outer edges (*ms*) and membranous down the middle (*m*). Tegmen forming a ring, with a large dorsal cap-piece slightly emarginate at tip, and a keel-like strut on the ventral aspect.

Internal sac long with two small pads (*a*) of chitinous short spines.

Caryoborus nucleorum (Pl. LXXII fig. 197).

Median lobe large, the distal two-sevenths forming a flattened tube, with the ventral edge of the median orifice pointed and projecting beyond the dorsal edge, the basal five-sevenths forming a large sclerite on the dorsal aspect. Tegmen forming a ring, with lateral lobes consolidated together forming a cap-piece, slightly emarginate at tip; at the base of the lateral lobes and consolidated to them there is a large, inflated semi-chitinated membrane (*a*) which is consolidated to the median lobe; this may represent a chitination of the first connecting membrane. On the ventral side is a Y with a long strut (*b*). Internal sac long, without complex armature.

This family comes within the Chrysomelid group.

Family CHRYSOMELIDAE.

Forms examined: As this is one of the most extensive divisions of Coleoptera, we arrange the species specially studied in thirteen groups.

1. ORSODACNINAE. *Orsodacne nigriceps* Latr., England.

2. DONACIINAE. *Donacia* (*Plateumaris*) *sericea* L., and *comari* Suffr., *D. bidens* Ol., *semicuprea* Panz., and *lemnæ* Fabr., England.

3. SAGRINAE. *Mecynodera balyi* Clark, Australia. *Carpophagus banksiae* Macl., Australia. *Diaphanops westermanni* Schönh., Fremantle, Australia. *Polyoptilus* sp. aff. *erichsonii* (not in Brit. Mus. Coll.), Australia. *Sagra amethystina* Guér. var., W. Africa. *Sagra nigra* Ol., Assam.

4. TIMARCHINAE. *Timarcha geniculata* Germ., Asturias. *T. tenebricosa* Fabr., England.

5. CRIOCERINAE. *Crioceris asparagi* L., England.

6. CLYTHRINAE. *Labidostomis longimana* L., Istria. *Clythra laeviuscula* Ratz., Pyrenees. *Lachnaca palmata* Lac. ? Pyrenees. *Saxinis saucia* Lec., California.

7. CRYPTOCEPHALINAE. *Cryptocephalus aureolus* Suffr. England. *C. asturiensis* Heyd. ? Asturias.

8. EUMOLPINAE. *Eumolpus surinamensis* F., S. America. *Chrysochus pretiosus* Fabr., Bohemia. *Glyptoscelis cuprascens* Lec., California.

9. CHRYSOMELINAE. *Orina elongata* Suffr., and *O. speciosa* L., Piedmont. *Chrysomela sharpi* Fowl., Scotland. *Gastrophysa raphani* Herbst., Scotland. *Paropsis variolosa* Marsh., Sydney. *Phytodecta 5-punctata* L., Piedmont. *Phyllodecta vitellinae* L., and *P. vulgatissima* L., England and Scotland.

10. GALERUCINAE. *Diabrotica soror* Lec., California. *Galerucella* spp., England.

11. HALTICINAE. *Haltica coryli* All., England.

12. HISPINAE. *Spilispa imperialis* Baly?, Australia. *Cephaloleia* sp. aff. *nigropictae* Baly?, S. America.

13. CASSIDINAE. *Mesomphalia pascoci* Baly, Ecuador. *Aspidomorphia 4-maculata* Ol., Nyasaland.

Figs. 198 to 216 Pls. LXXII, LXXIII, and LXXIV, relate to these forms.

Orsodacne nigriceps (Pl. LXXII fig. 198).

Distal half of the median lobe forming a flattened tube, with the ventral edge of median orifice slightly cleft at tip, and projecting beyond the dorsal edge, the basal half formed of two long struts on dorsal aspect. Tegmen forming a ring-piece with cap divided at tip. Internal sac long, projecting much beyond the median foramen. A slightly chitinated cone at the apex carries the opening of the ejaculatory duct.

The two struts of the median lobe and the long sac place this nearer to the Longicorn type than to other Chrysomelidae.

Donacia sericea (Pl. LXXII figs. 199, 199a, 199b).

Median lobe large, chitinous, tubular and curved, with the median orifice at apex and the median foramen large, occupying the ventral face of the basal half (*mf*). Tegmen forming a ring-piece; on the dorsal side the cap forms a slender lobe with hairs at the tip on the ventral face. The strut forms a large keel. Internal sac large with complex armature at its apex. This armature consists of a pair of lateral curved plates (*c*) and a median process (*b*) through which the ejaculatory duct passes and opens on its tip, a chitinous block (*d*) supports the structure at its junction with the membrane.

D. comari.

Is very like *D. sericea* but the cap is divided at the tip. The arma-

ture on the apex of the internal sac differs in details (Pl. LXXII figs. 200, 200a).

D. bidens and *D. semicuprea*.

Aedeagus very like *D. comari*, but the armature on the sac is totally different (Pl. LXXIII, figs. 201 and 202).

D. lemnae.

Has the cap long and thin. The armature on sac is distinct from those described above (Pl. LXXIII fig. 203).

Carpophagus banksiae (Pl. LXXIII figs. 204, 204a).

Median lobe large, chitinous, tubular and curved; the median orifice at apex, the median foramen occupying the ventral basal half. Tegmen forming a ring-piece, with a very long lobe as cap. Internal sac large with complex armature at apex (204a) consisting of a pair of complex side lobes (*c*) and a slender median process (*b*) through which the ejaculatory duct passes and opens on its apex.

Mecynodera balyi.

Median lobe well chitinated, curved and fairly short, forming a flattish tube; the ventral edge of the median orifice projecting beyond the dorsal edge: median foramen large, occupying the ventral portion of the basal half. Tegmen forming a ring-piece, with large cap apically deeply divided and furcate; the median strut or keel on the ventral aspect, of median size. Internal sac not extending through the median foramen. Armature at apex of sac consisting of a slender median process on which the ejaculatory duct opens, two chitinous plates embedded in the membrane below the median process, and a Y-piece above also embedded in the membrane.

Polyoptilus sp.

This is very like *Mecynodera* but the cap is less furcate at the tip.

Diaphanops westermanni.

This is very like *Polyoptilus* sp. ?; the cap is differently shaped, being broader distally and bearing there a small emargination; the armature at the apex of the internal sac (Pl. LXXIII fig. 205) consists of a slender process on which the ejaculatory duct opens (*a*) protected by a stronger and broader process above it (*b*), a broad plate (*c*) grooved along the centre supports the membrane below and another and smaller plate (*d*) supports the membrane above. *N.B.*—In the figure, (*d*) and its pointing line are imperfect.

Sagra amethystina (Pl. LXXIII figs. 206, 206a).

Median lobe well developed, chitinised, tubular and curved ; the ventral edge of the median orifice projecting beyond the dorsal edge, pointed but not cleft. There is a very long prolongation of the tegmen dorsally, and this is grooved along the middle, and has a short, narrow division at tip. Internal sac not projecting beyond the median foramen, which is large and occupies the ventral portion of the basal half of the median lobe. Sac complex in shape, with two sclerites on each side of the base (*a—a*) to support it ; armature at apex consisting of a slender median process on which the ejaculatory duct opens, with another brush-like process above it and chitinous sclerites supporting its base.

Sagra nigrita.

Of the same type as *Sagra amethystina* ; the armature at apex of sac consisting of a slender process on which the ejaculatory duct opens, protected by a wider and curved process above, broadened at the base where it is attached to the sac ; on each side is a patch of stiff hairs.

Crioceris asparagi.

Median lobe well developed and chitinised, with the ventral lip of the median orifice projecting slightly beyond the dorsal edge ; the median foramen occupying the greater part of the ventral surface of the basal half. Tegmen consisting of a small Y-piece and a moderate-sized strut, or keel, on ventral aspect, dorsal part entirely membranous and without any trace of prolongation as cap. Internal sac short with a strong chitin-piece at apex on which the ejaculatory duct opens.

Labidostomis longimanus.

Median lobe forming a well chitinised, short, nearly straight tube, slightly flattened on dorsal side of distal half, with the ventral edge of the median orifice projecting beyond the dorsal edge ; median foramen large, occupying the ventral aspect of the basal half ; a slight constriction divides the basal and distal halves. Tegmen consisting of a small shield-shaped-piece, keeled along the middle on the inner side, on the ventral aspect of median lobe, without traces of lateral lobes. Internal sac short, with complex chitinous armature which closes the median orifice. Stenazygos excessively elongate, many times longer than the whole insect.

Clythra laeviuscula (Pl. LXXIII fig. 208).

Median lobe well developed and chitinised, forming a tube, the

distal half flattened on the dorsal aspect and bearing three keels, a median and a pair of lateral; the ventral edge of the median orifice coming to a small point but not projecting far beyond the dorsal edge; slightly constricted about middle; median foramen occupying the ventral aspect of the basal half. Tegmen in form of a shield-shaped sclerite, with the corners not meeting on the dorsal face, and no trace of prolonged cap. Internal sac small with complex armature consisting of a long chitinous flagellum (*a*) and a pair of strong, curved, chitinous spines (*b*). Stenazygos not investigated.

Lachnaea palmata.

In this species the median lobe is well developed, curved near the apex, but straight beyond. The armature on sac consists of a small spine-like flagellum and a pair of large spines, with a complex process closing the median orifice consisting of a plate bearing a median curved tongue and a pair of lateral, rounded plates. The tegmen is Y-shaped, the strut being slender and bifurcate at end.

Saxinis saueia.

Median lobe very slightly curved, with the ventral edge of median orifice pointed and extending slightly beyond dorsal edge; the median orifice closed by the armature on the sac. Median foramen occupying the ventral portion of basal half. Tegmen V-shaped.

Cryptocephalus aureolus.

Median lobe well developed and chitinised, the distal half being considerably flattened; the ventral edge of median orifice drawn out to a fine, flattened point, with the tip curved downward, projecting much beyond the dorsal edge; median foramen occupying the whole of the ventral side of the basal half. Tegmen shield-shaped, with a keel along the middle of the inner side. Armature on sac not examined.

Cryptocephalus asturiensis?

Of the same type as *C. aureolus*, but the ventral edge of the median orifice drawn out into a blunt point and not turned downward. Armature on sac complex, that at the base closing the median foramen; at the apex there are two broad, bifurcated spines and a flattened median sclerite, but no flagellum.

Eumolpus surinamensis (Pl. LXXIII figs. 207, 207a).

The apical third of the median lobe strongly curved and slightly flattened, the ventral edge of the median orifice pointed and projecting far beyond the dorsal edge, the basal two-thirds consisting

of a broad curved piece on the dorsal side, the ventral part being occupied by the median foramen; between the distal third and the basal two-thirds there is a strong constriction. The tegmen consists of a Y-piece, with a long strut on the ventral aspect and only membrane on the dorsal, and without trace of cap-piece. Internal sac long, with apical armature consisting of a twisted chitin plate (α) through which the ejaculatory duct runs, and opens on its apical edge (207a). Beyond (basally) the sac the duct forms a long chitinous tube, four times the length of the aedeagus, and then enlarges somewhat so as to become a slender chitinous chamber.

This is very remarkable on account of the extreme elongation of the stenazygos. Apparently this part, which is at least four or five times as long as the eurazygos, is also made as slender as possible. It is difficult to say whether it is not rather an altered part of the eurazygos than a specialisation of the duct.

It may possibly function as a flagellum, invaginated during inactivity. A thorough examination of this structure and its function in Eumolpidae would be very interesting. In *Chrysochus pretiosus* this stenazygos (or pseudostenazygos) is quite as slender as in *Eumolpus*.

Glyptoscelis cuprascens.

Median lobe well developed and chitinous, bent at right angles about middle, the distal half forming a flattened tube, with the ventral edge of the median orifice drawn out beyond the dorsal edge and pointed; the median foramen placed on the ventral aspect of the basal half. The dorsal face of the basal half cleft down the centre making it into two struts. Tegmen forming a broad shield-shaped sclerite, the apex of the shield being attached to the median lobe and the wide part extending ventrally, not meeting on dorsal side of median lobe and having no trace of cap-piece. Sac and stenazygos not examined.

Orina elongata (Pl. LXXIII fig. 209).

Median lobe well developed and chitinated, curved, tubular, with the ventral edge of the median orifice drawn out to a point greatly beyond the dorsal edge, thus placing the median orifice on the dorsal aspect; median foramen smaller than in Eumolpinae, etc., occupying only the basal sixth of the ventral aspect. Tegmen consisting of a small V-shaped sclerite, not meeting on dorsal aspect and showing no trace of cap-piece. Internal sac of moderate size, with a strongly chitinated flagellum on which the ejaculatory duct opens.

Orina speciosa.

Median lobe forming a long, fairly slender tube, slightly curved; ventral edge of median orifice bluntly pointed, turned downward and projecting slightly beyond the dorsal edge, which is rounded and turned upward; median foramen occupying the ventral face of the basal sixth. Tegmen forming a V-piece, not meeting on dorsal aspect and without any trace of cap-piece. Internal sac nearly as long as the median lobe with a fairly thick flagellum arising from the apex, and through which the ejaculatory duct passes, nearly as long as the sac.

Gastrophysa raphani.

Median lobe very short and broad; the ventral edge of median orifice pointed and projecting beyond the dorsal edge; the dorsal edge forming a flat fold, or lid, over the orifice, thus giving it a horse-shoe shape. Tegmen forming a V-shaped piece on ventral aspect of the median lobe. Sac not examined.

Chrysomela sharpi.

Median lobe well developed and chitinated, with the ventral edge produced somewhat beyond the dorsal edge and rounded, the median foramen occupying about one-sixth of the ventral basal portion. Tegmen forming a semi-ring without trace of cap-piece. Internal sac large, with a curved, slender flagellum on which the ejaculatory duct opens.

Paropsis variolosa? (from Sydney) (Pl. LXXIV figs. 210, 210a).

Median lobe well developed and chitinated and flattened horizontally; the ventral margin of the median orifice bluntly pointed and produced far beyond the dorsal edge, thus placing the orifice in a dorsal position; median foramen occupying one-sixth of the basal ventral portion, which is slightly constricted off from the distal five-sixths. The chitination of the dorsal edge of the median orifice is continued on to the base of the internal sac as two short broad strips (a). Tegmen forming a slender semi-ring-piece, with only a minute strut (s) and not meeting on the dorsal aspect. Internal sac large, bearing a strong, curved flagellum on which the ejaculatory duct opens. This form comes near to *Orina*.

Phytodecta 5-punctata.

Median lobe tubular and slightly curved; the lateral edges of the median orifice produced into two flattened, curved spines which curve over the orifice; median foramen occupying the ventral basal

third. Tegmen V-shape. Internal sac nearly as long as the median lobe, bearing at its apex a curved flagellum slightly longer than the sac.

Phytodecta olivacea.

Is near to *P. 5-punctata*, but the lateral spines at the edge of the median orifice are greatly flattened, meet on the median ventral line, and curve downward, and are asymmetrical, the right one being produced into a short point on the outer side and the left rounded. Internal sac bearing a flagellum.

Phyllodecta vitellinae (Pl. LXXIV figs. 212, 212*a*, 212*b*).

Median lobe stout, tubular, constricted one-fourth from the base; the ventral edge of median orifice produced beyond the dorsal edge and bluntly pointed; median foramen occupying the ventral aspect of the basal fourth, on the dorsal aspect of the base is a deep emargination. Tegmen forming nearly a complete ring, but not quite complete on the dorsal face, no trace of cap-piece. Internal sac short, bearing armature in the shape of a flat, curved spine on each side (*a*) and a median complex plate (*b*).

We have examined several of two varieties that go under this name, a blue variety from Forres sand-hills and a southern one, with a bronzy green form; in these we find a constant difference in the shape of the emargination on the dorsal edge of the base of the median lobe, the northern variety has a round emargination (fig. 212*a*) and the southern a nearly parallel-sided emargination (fig. 212*b*). More extended observations on this species are greatly to be desired. We think it possible that there may be two.

Phyllodecta vulgatissima.

This is near to *P. vitellinae*, but the distal end of the median lobe is more flattened horizontally, and the constriction near base is not so deep. The armature on sac is on the same plan, but more complex and lies inside the median orifice, and when the sac is slightly evaginated entirely alters the appearance of the orifice.

Timarcha geniculata (Pl. LXXIV fig. 211).

Median lobe well developed and chitinated, the ventral edge pointed and produced a little beyond the dorsal edge, the dorsal edge forming a pointed strip over the orifice; median foramen occupying the ventral aspect of the basal third, the dorsal face being cleft, thus making it into a pair of struts (*ms*). Tegmen forming a ring-piece with a curved plate, or cap, on dorsal aspect, shallowly

emarginate at tip, on the ventral aspect the ring-piece projects as a long strut (*b*). Sac large, with a slender flagellum (*fy*) rising from the apex.

The basal part of the median lobe being divided into two pieces, and the complete ring-piece with a cap on the dorsal side separate this genus from the Chrysomelinae. *C. tenebricosa* is of the same type, but the cap-piece is smaller in proportion. Hence we propose Timarchinae as a distinct subfamily. As Donaciinae and Sagrinae approximate this structure, the Timarchinae should be placed between them and Chrysomelinae.

Diabrotica soror.

In this Galerucid the median lobe forms a long, curved tube: the basal foramen extends ventrally for one-third of the length of the tube: at the distal extremity there is a short acumen, and the dorsal face of the tube is membranous for nearly one-third of the length. The tegmen consists of a pair of slender, nearly parallel and nearly contiguous rods, these diverge very abruptly, and then converge again a little so as to partially embrace the median lobe, but they are unconnected by chitin on the dorsal aspect.

Galerucella spp.

Agree with the above in respect of the tegmen; but the basal part of the median lobe is very different, the tube being more complete at the base, and provided there with a pair of hooks. These hooks also exist in *Galeruca tanacetii* and in *Lochmaea*. In the last-mentioned genus the median lobe is of highly irregular form, and instead of forming a single curve, the two extremities of the organ are curved in opposite directions (as occurs less markedly in *Haltica*).

So far as we can form an opinion as to the Galerucinae from the few forms examined, it would appear that their chief characteristics are (1) the indefinite delimitation of the median orifice, entirely dorsally placed and unprotected; and (2) the small tegmen, forming only delicate rods.

Haltica coryli.

Median lobe straight, tubular, somewhat flattened, ventral edge of median orifice produced into a point, projecting beyond the

dorsal edge ; chitinisation of the dorsal edge forming three strips which close the orifice ; median foramen occupying the ventral portion of the basal fourth. Tegmen Y-shape without traces of cap-piece. Internal sac fair size with armature that appears to be comparatively simple.

Although the aedeagus in Halticinae is much used for discriminating the species, we have not met with any satisfactory account of it ; the sac, with its armature, the base of the median lobe, and the foramen, as well as the condition of the tegmen, being in fact almost entirely neglected.

Spilispa imperialis (Pl. LXXIV fig. 213).

Median lobe well developed and chitinised, strongly bent at about two-thirds from apex, bent up at right angles at the curve, with the median foramen occupying the ventral portion ; median orifice with ventral edge rounded and produced beyond dorsal edge. Tegmen T-shaped, with the forks of the T embracing the median lobe.

Cephaloleia sp. ? (Pl. LXXIV fig. 214).

Median lobe tubular, strongly curved, with ventral edge of median orifice pointed and projecting far beyond the dorsal edge ; median foramen occupying the ventral portion of the basal third. Tegmen Y-shape. Internal sac long, passing through the median foramen ; nature of armature not observed.

Mesomphalia pascoei (Pl. LXXIV figs. 215, 215a).

Median lobe long, thin, tubular and flattened slightly, curved nearly at right angles about one-fourth from base and deeply constricted ; median foramen occupying the ventral portion of the basal fifth ; ventral edge of median orifice pointed and projecting well beyond dorsal edge. Tegmen Y-shaped. Internal sac not large, bearing at apex a flattened tube like flagellum (*fg*), on which the ejaculatory duct opens, and a plate embedded in the sac below (*a*). The ejaculatory duct in this species is semi-chitinous, and forty-eight millimetres long.

Aspilomorpha 4-maculata (Pl. LXXIV fig. 216).

Median lobe stout, tubular and bent at forty-five degrees two-fifths from base ; median orifice with ventral edge bluntly pointed and only produced a little beyond dorsal edge ; median foramen occupying ventral part of basal fifth. Tegmen Y-shape. Internal sac without armature.

The Chrysomelidae form an interesting series of groups which further research will perhaps separate into distinct families. The most primitive type is *Orsodacne*, which approaches *Parandra*. We find forms wherein the tegmen is not divided, though it has a comparatively large cap (*Timarcha*), and others in which the median lobe becomes tubular, *Orina*, etc. Apparently a still more modified form is that in which the tegmen is reduced to a delicate Y or V-shaped piece. An overwhelming majority of the existing species belong to the divisions in which the tegmen is thus reduced (*Chrysomelinae*, *Galerucinae*, *Halictinae*). The modifications of the tegmen will probably be found of considerable assistance in the classification of this enormous group of Coleoptera.

Family CERAMBYCIDAE

Forms specially examined: *Parandra* sp. n.? New Guinea. *Mallaspis xanthaspis* Guér.?, ? Colombia. *Aromia moschata* L., England. *Chloridolum dorycum* Boisd., New Guinea. *Gnoma ctenostomoides* Th., New Guinea. *Monoctamus longicornis* Th., New Guinea. *Macrochenus guerini* White, ? N. India. And various others not calling for special remark.

Figs. 217 to 221 Pls. LXXV and LXXVI.

Parandra sp.? (probably undescribed) (Pl. LXXV fig. 219).

Median lobe somewhat flattened horizontally with dorsal and ventral edges of median orifice pointed, the orifice extending back some distance on each side; from the dorso-lateral edges of the base two flat, narrow struts are given off. Tegmen forming a ring with a pair of pointed processes, separate to near their base, on the dorsal aspect, and a median strut (*cs*) on the ventral aspect. Internal sac large, without armature.

Aromia moschata.

In this well-known insect (Pl. LXXV fig. 217), the sac is largely developed, and bears a complex armature near the apex (*a*).

Chloridolum dorycum.

This is similar to *A. moschata*, but the armature of the sac is even more complex, and is shown in some detail in figs. 218 and 218a Pl. LXXV. There is a deeply cleft chitinous plate (*ab*) bearing hair at the two extremities (*ac*); a large chitinous plate

(d) with the sides curved up, and another plate (e) below it, and this is produced into a blunt median keel (f); there is a large diverticulum (g) as in *Aromia*. A considerable part of the sac is beset with small, chitinous teeth.

Among the forms of this large family that we have examined there is a great uniformity of type, the median lobe having the orifice at the tip and extending along the side, the sclerites on the dorsal and ventral aspects being separated by a membrane running along each side, from orifice to foramen; the base of median lobe prolonged into two struts; tegmen ring-shaped, with a divided projecting process, the division generally very deep; internal sac long, projecting into the body forwards beyond the median foramen in the state of repose.

It is in the great development of the sac, and the diversities in its armature that we must seek the peculiarities of the family. *Parandra*, so far as the genital tube is concerned, appears to be the lowest form; in it we have found no specialisation of importance. A general resemblance between the tube of *Parandra* and that of *Cucujoidea* is evident at first sight (compare *Parandra*, fig. 219 with *Cucujus*, fig. 97, or *Passandra*, fig. 96). In the section phylogeny we have shown reasons for supposing that this general resemblance may be deceptive.

We have examined various other Cerambycidae without finding anything to make it necessary to increase the length of this memoir by including them. But there is one point we must mention briefly. Bordas has pointed out that in certain Cerambycidae there appear to be present two ejaculatory ducts. In other words that the stenazygos is wanting. We also have observed this fact in *Gnoma* (Pl. LXXV fig. 220) and in some species of *Monohammus* (Pl. LXXVI figs. 221 and 221a).

That this fact is of much morphological importance is not clear to us. It may perhaps be due to the great extension of the sac (or eurazygos). And in fact in another closely allied species of *Monohammus* we have found a distinct stenazygos. The structure as it has appeared to us in *Monohammus longicornis* is shown in Pl. LXXV fig. 221, and in 221a where the sac is everted. It is then seen to be studded with small spines, and bears two diverticula, thus acquiring a singular resemblance to the head of a dog; and it will be seen that there is a short

tube (*a*) into which the two ducts lead. In the absence of knowledge as to the development it is not advisable to attempt an explanation of this form, but it appears to be not improbable that it may represent the stenazygos. The student will in looking at this figure recollect that the part of the sac that is the more anteriorly placed is really the apical part; the sac in *Cerambycidae* being completely inverted, the junction of the ducts with the sac is really the apical, or distal, portion of the genital tube.

Family ANTHRIBIDAE.

Form examined: *Phlocobius alternans* Wied., India. Figs. 225 and 225*a* Pl. LXXVI.

Phlocobius alternans (Pl. LXXVI figs. 225, 225*a*).

Median lobe forming a short, flattened tube; the ventral and dorsal edges of median orifice pointed, the ventral projecting beyond the dorsal, the orifice thus forms a slit extending back along the sides; at the base the median lobe is prolonged into a pair of long, thin struts (*ms*). Tegmen forming a ring with dorsal cap-piece and a ventral strut, the cap-piece having a ridge across where it becomes more strongly chitinised, and at the tip bearing long hairs. Internal sac large, having a large diverticulum, and at its apex a membranous flagellum-like organ.

The few other Anthribidae that we have examined are all on the same type although the details differ.

Family CURCULIONIDAE.

Forms examined: *Eupholus chevrolati* Guér., New Guinea. *Polycleis plumbeus* Guér., S. Africa. *Brachycerus apterus* L., S. Africa. *Belus bidentatus* Macl., Australia. *Mecocorynus loripes* Chevr., E. Africa. *Sphenophorus obscurus* Boisd., Hawaia.

Figs. 222, 223 and 224 Pl. LXXVI.

Eupholus chevrolati (Pl. LXXVI figs. 222, 222*a*).

Median lobe a short flattened tube, with ventral edge of median orifice projecting beyond dorsal edge, and pointed; from each side of base projects a long median strut (*ms*). Tegmen forming a ring-piece with a pair of delicate, but quite distinct prolongations on the dorsal aspect, and central strut on the ventral aspect. Internal sac long,

reaching beyond the ends of the median struts, with a stout, curved, spine-like flagellum at the apex and a large diverticulum (*a*) below it.

Polycleis plumbeus.

Median lobe well chitinised, tubular, slightly flattened and curved; ventral edge of median orifice projecting beyond dorsal edge and bluntly pointed; median struts small and slender, only half as long as the median lobe. Tegmen forming a ring-piece with a pair of small delicate projecting lobes on dorsal aspect and a slender central strut on ventral aspect. Internal sac contained within median lobe.

With the increased chitinisation of the median lobe there is here a reduction of the median struts.

Brachycerus apterus.

Median lobe forming a short flattened tube, with the ventral edge of median orifice projecting beyond the dorsal edge and pointed; median struts large. Tegmen forming a ring-piece with lateral lobes consolidated into a cap-piece on dorsal aspect; central strut on ventral aspect large. Internal sac long with armature which we have not examined.

Belus bidentatus (Pl. LXXVI fig. 223).

Median lobe forming a straight chitinous tube, with a pair of short median struts; median orifice at apex. Tegmen forming a wide ring-piece with a long narrow cap-piece; central strut large. Internal sac long, projecting some way beyond the median struts. A fine chitinous tube (*a*) projects through the apex of the sac, and ends in a membranous flagellum (*fg*); the chitinous tube (*a*) appears to have the power of being moved through the apex of the sac. The apex of the sac is supported by two crescent-shaped sclerites (*b*), one on each side of the tube. The dorsal and ventral aspects of the internal sac are supported by two chitinous plates from near the apex to the base.

The long, slender sac with the flagellum at the apex recalls the highly specialised flagella and long sacs of the Brentheids.

Sphenophorus obscurus (Pl. LXXVI figs. 224, 224*a*).

Median lobe forming a semi-chitinous tube, supported along each side by a chitin strip (*a*), the median orifice is at the apex on the dorsal face and is supported by a chitinous ring. From the basal ends

of the lateral chitin strips proceed two median struts (*ms*). Tegmen formed of a semi ring-piece with a very strong central strut on the ventral face. A long first connecting membrane (*cm* 1) connects the tegmen to the median lobe, and a very long second connecting membrane (*cm* 2) connects the tegmen to the body wall; the basal part of this second connecting membrane (*cm* 2) is chitinised and forms a tube around the aedeagus; on the right of it is attached the "spicule" (*sp*). Internal sac large, without armature.

Obs.—We have examined various other Curculionidae without finding distinctions of great importance. But the various specialisations will probably prove to be of much assistance in the classification of this enormous complex. Comparison of the cap-piece of the tegmen in Attelabini, Rhynchitini and Brachycerini with long-rostrum-forms (*i.e.* probably higher) like *Mecocorynus* is suggestive of this.

Family SCOLYTIDAE = (Ipidae of some).

Form examined: *Tomicus* (*Ips* of some) *laricis* Fabr., England.

Fig. 226 Pl. LXXVII.

The male organs of many of this family were carefully figured and described by Lindemann* and again by Verhoeff.† It is a Rhynchoporous type. We figure *Tomicus laricis* (Pl. LXXVII fig. 226). Median lobe short and tubular, with a pair of slender median struts. Tegmen ring-shaped with a central strut on ventral side (*a*). Internal sac fairly long, with a thin membranous flagellum arising from the apex, supported by a couple of thin chitin rods (*b*).

We must refer workers in this group to Lindemann's above-mentioned paper for details of the various species.

The evolution of the tegmen in this family appears to be from a ring-piece with well developed lateral lobes, to reduction of the lateral lobes, the ring-piece being correlatively reduced into a small Y-piece on the ventral side of the median lobe. Cf. remarks on Chrysomelidae.

Family PLATYPIDAE.

Form examined: *Platypus* (*sp.*), Honolulu. *Crossotarsus barbatus* Chap., New Guinea.

* Bull. Soc. Imp. Mosc., Vol. XLIX (1875) No. 1.

† Archiv f. Naturgesch. 1896.

Crossotarsus barbatus (Pl. LXXVII fig. 228).

Median lobe forming a strong chitinous tube with the median orifice at the apex and the median foramen occupying the ventral basal third. Tegmen forming a Y-piece. Internal sac not examined.

Family BRENTHIDAE.

Forms examined: *Baryrrhynchus miles* Boh., India. *Arrhenodes funbris* Sharp, Panama.

Fig. 227 Pl. LXXVII.

Baryrrhynchus miles Boh. (fig. 227).

Median lobe forming a tube for the apical two-fifths, chitinous on dorsal and ventral aspects; the dorsal sclerite prolonged into two wide struts at the base (*ms*). Tegmen forming a ring, with a pair of large, rounded lobes, forming one piece basally, on the dorsal aspect and a long strut-like basal-piece ventrally. Internal sac long, projecting beyond the base of the median lobe, and armed with a long, slender, chitinous flagellum (*fy*, fig. 227) about 12 mm. long, and .006 mm. in diameter towards its tip; the opening of the ejaculatory duct is at the tip of the flagellum.

We have examined various other Brenthidæ, and as far as we have observed, this family is very uniform, differing in the size and shape of the cap-piece, of the median lobe, flagellum, etc.; but all possess the flagellum, and the division of the cap-piece is never missing. In *Baryrrhynchus robustus* Jek., the lobes are slender rods, bearing hairs at the tip, but are quite distinct.

Family LUCANIDAE.

Forms examined: *Chiasognathus granti* Steph., Chile. *Necolamprina adolphinae* Gestro, New Guinea. *Lucanus cervus* L., England. *Systemus* (formerly *Platyccerus*) *caraboides* L., Bosnia. *Figulus marginalis* Rits., Borneo. *F. striatus* Ol., Seychelles. *Syndesmus cornutus* Fabr., Tasmania. *Ceratognathus niger* Westw., Tasmania. *Mitophyllus irroratus* Parry, and *M. parryi* Westw., New Zealand. *Aesalus scarabacoides* Panz., Europe. *Nicagus obscurus* Lec., N. America. *Sinodendron cylindricum* L., Brockenhurst.

Figs. 5-10a Pls. XLII and XLIII.

Ceratognathus niger (Pl. XLII fig. 5).

The median lobe is long, tubular, with median orifice at tip and
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small median foramen at base. Lateral lobes as long as median lobe, the basal half of each embracing the side of the basal half of the median lobe, the distal half narrow and curved. Basal-piece very small. Internal sac small with a large patch of long brown hair but no armature.

Mitophyllus parryanus.

Closely allied to *Ceratognathus*. Median lobe well developed, cylindrical, slightly constricted near the tip and rounded at the base; median orifice at the distal end, membranous round the orifice and from there graduating off to strong chitin on the rest of the lobe; small median foramen at base; point of articulation on dorsal side. Lateral lobes twice as long as the basal-piece, reaching to the end, and embracing the sides, of the median lobe. Basal-piece about one-third the length of the tegmen, with small basal opening. Internal sac small, covered with fine brown hairs, but no armature.

Mitophyllus irroratus.

The basal-piece has quite disappeared, the lateral and median lobes as in *Ceratognathus*, but the basal parts of the lateral lobes entirely envelop the basal part of the median lobe. Internal sac small with very dense covering of chitinous, elongate, pointed scales; the ejaculatory duct long and coiled up in the median lobe so as to allow enough slack when the sac is evaginated. An important difference exists between this species and *M. parryanus*.

In these forms the muscles for working the median lobe are attached to its base, there being no median struts.

Syndesus cornutus (Pl. XLIII figs. 6, 6a, and 6b).

The median lobe is well developed, bottle-shaped, with the median orifice at the distal end and the small median foramen at the base (*mf*), around which the chitin is much thicker and stronger and supports the point of articulation and the attachment of two median struts. Lateral lobes broad at the base and bluntly rounded at the tips which reach slightly beyond the tip of the median lobe; the bases of the lateral lobes embrace the sides of the base of the median lobe. Basal-piece large and shield-shape, membranous on the dorsal side. The internal sac without armature but very long (21 mm.) and doubled up in the median lobe. The median foramen is very small and it is not likely that the ejaculatory duct passes through when the sac is evaginated, consequently only half the sac can be evaginated.

This is a very interesting form, in connection with the question of the function of the flagellum generally. Does the portion of the sac that can be evaginated (to the extent of at least 10 mm.) act in a similar way to the highly developed flagellum of *Lucanus*?

Systemus caraboides (Pl. XLIII figs. 7 and 7a).

The median lobe is formed of a strong bilobed plate on the ventral side, with a ridge across each lobe (*a*, fig. 7a), the one on the right being larger than the one on the left; the dorsal side is membranous, except at the base round the small median foramen, where there is a ridge for the point of articulation (*pa*) and the attachment of the median struts. The lateral lobes are broad, short and truncate and embrace the basal sides of the median lobe, but do not meet either on the dorsal or ventral faces. The basal-piece is large, shield-shaped, with the edges turned up; the dorsal side being membranous. The internal sac is large and complex and is permanently evaginated and bears a short flagellum (*fg*) through which the ejaculatory duct passes to the orifice at the tip. When at rest the sac collapses upon itself and lies on the dorsal side of the median lobe, but under blood pressure swells out (fig. 7a).

Lucanus cervus (Pl. XLIII fig. 8) and *Chiasognathus granti*.

Are on the same plan as *S. caraboides*, but the flagellum is very greatly elongated.

Figulus marginalis.

Median lobe small, tubular and curved, with a pair of median struts consolidated along their basal half, the internal sac is fairly large and appears to be permanently everted and has no flagellum. Lateral lobes small. Basal-piece about twice as long as the lateral lobes, forming a slightly flattened tube; from the distal edge of the ventral side there is a small curved tongue which covers and hides the median lobe.

F. striatus.

Is of the same type but has a long flagellum. The question of these two species remaining in the same genus is doubtful. This type approaches *Sinodendron*.

Neolamprima adolphinae (Pl. XLIV figs. 10 and 10a).

Has a long, strong, cylindrical basal-piece, with small lateral lobes. The median lobe is small, thin and cylindrical, with two short

broad median struts, and from the base proceed two long, flattened supports (*a*) that connect it to the lateral lobes. No differentiated internal sac.

Acsalus scarabacoides.

Has a long, tubular median lobe, slightly curved; median orifice at distal end and median foramen at base. Tegmen consisting of a small ring-shaped basal-piece with narrow (almost hair-like) lateral lobes about two-thirds as long as the median lobe, and closely appressed thereto; these are all amalgamated at base and show no articulation. Internal sac not observed. This distinct form is worthy of more investigation. We have had only one example at our disposal.

Nicagus obscurus.

Since our paper was written Mr. Schwarz has kindly given F. Muir an opportunity of dissecting this problematic form, and he finds that it is a Lucanid, not a Scarabaeid. The description and remarks on its affinities must be published elsewhere.

Sinodendron cylindricum (Pl. XLIII figs. 9 and 9*a*).

The median lobe is small, curved, tubular and highly chitinised; the median orifice at the distal end; the median foramen, a long narrow opening along the ventral basal aspect; a pair of large median struts are articulated to the base; the point of articulation has a dorso-basal position. The lateral lobes are small, concave across the inner side (*a*) where the median lobe lies. The basal piece forms a large, strongly chitinised tube. The internal sac undifferentiated, the basal part (*b*) is always protruding from the median orifice.

In the Lucanidae there are several types of aedeagus, but they all differ from the Scarabaeidae in having a well-developed chitinous, exposed median lobe, and the internal sac is never developed to so great an extent as in the Scarabaeidae, unless we consider the flagellum as a modified sac. In that case the sac in the forms of the two families may be said to be very different.

In our taxonomical table we have suggested a division of Lucanidae into three families, Lucanidae, Lamprimidae and Sinodendronidae. This seems necessary if Trogidae are separated from Lucanidae. The alternative is to unite the five divisions, Trogidae, Scarabaeidae, Lucanidae, Lamprimidae and Sinodendronidae into a single family.

The diversity of these forms is in striking contrast with the homogeneity of Caraboidea, Rhynchophora, Cerambycidae.

Family TROGIDAE (fam. nov.).

Forms examined: *Trox omacanthus* Har., Pusa; *T. scaber* L., Brockenhurst; *T. suberosus* Fabr., Brazil; *T. penicillatus* Fahr., Hedjaz; *T. sp.*, Queensland; *T. sp.*, N. Australia (these two not named in Brit. Mus. Coll.). *Glaresis beckeri* Solsky, Transcaspian. Also the following forms classified with the family but not really belonging to it, viz. *Clootus rugiceps* Germ., Rio de Janeiro; *C. sinuatus* Bates, Guatemala; *Liparochnrus timidus* Arrow, N. Australia; *Anaides laticollis* Har., Mexico; *A. simplicollis* Bates, Costa Rica; *Nicagus obscurus* Lec., N. America.—For *Clootus*, *Liparochnrus* and *Anaides* vide Coprini in Scarabaeidae; for *Nicagus* vide Lucanidae.

Figs. 1, 2, 2a, 3, 3a, 4, 4a, Pl. XLII.

Trox omacanthus (Pl. XLII figs. 2 and 2a).

Median lobe broad, flattened and rounded at tip, with a slight depression down the dorso-median line; median orifice across the ventral face of tip, the dorsal tip projecting some distance beyond it. Lateral lobes broad and short, nearly meeting at their bases on the dorsal side, but well separated on the ventral side; tips pointed. Basal-piece well developed, membranous along the middle on ventral face, chitinous on dorsal face. Internal sac large, covered with short brown hairs; no chitinous armature. The testes of this species consist of six long, simple, sausage-shaped glands, attached by very short stalks to the ends of the long vasa deferentia, which are not coiled up in a bunch as in *T. scaber*, q. v.

Trox scaber (Pl. XLII figs. 3 and 3a).

Median lobe well developed, broad, flattened and truncate at the tip; median orifice on ventral face near base (*mo*), two long median struts (fig. 3a, *ms*) are articulated to the lateral edges of the base of the median lobe; point of articulation on dorsal side. Lateral lobes slightly longer than median lobe; pointed at apex, their bases nearly meeting on dorsal side, far apart on ventral side. Basal-piece forms a broad, flattened, chitinous tube, bent near the base. No differentiated internal sac.

It is of interest to note that the testes of this species are of a simple form. The vasa deferentia are very long

and the ends of them coiled up into balls as in the Carabidae; situate near their extremity are six small, simple, globular glands attached to the vasa deferentia by slender, short ducts. These globular glands are simple and have none of the complex structures of such forms as *Melolontha vulgaris*.

Trox penicillatus (Pl. XLII figs. 4 and 4a).

This is similar to *T. scaber*, but more complex, especially the median lobe. There is no differentiated sac.

Trox sp. ? 1, N. Australia (Pl. XLII fig. 1).

Median lobe broad, flattened, curved and pointed at tip, with a little ridge running down the middle of the dorsal side; median orifice across tip on ventral side. Lateral lobes well developed, embracing the lateral edges of median lobe nearly to the tip, not meeting together at base either on dorsal or ventral side. Internal sac small but distinct, without armature.

Trox sp. ? 2, N. Queensland.

This is of the same type as *T.* sp. ? 1; the median lobe is broad, flattened and pointed at the tip; the median orifice situated across the tip, the lower pointed lip of which turns down when the sac is evaginated. Lateral lobes only embracing the sides of the median lobe and not meeting on either side at their bases. Basal-piece small, membranous on dorsal side, large at the sides where the lateral lobes are articulated and a narrow chitinous strip on the ventral side. Internal sac short, with curved chitin plate as armature.

Trox suberosus.

Similar type to *Trox* sp. ? 2, but the basal-piece is longer. Internal sac short, covered with fine soft hair, and on the ventral side with a curved chitinous plate which projects beyond the sac when evaginated.

Glaresis beckeri.

Median lobe large, well developed, with pointed tip turning up dorsally; membranous on ventral side; median orifice on ventral side near tip; point of articulation on dorsal side. Lateral lobes slightly longer than median, nearly meeting at their base on dorsal face; concave on the inner side and embracing the dorso-lateral part of the median lobe; tips bluntly pointed. Basal-

piece as long as the median lobe, forming a broad, flattened chitinous tube bent downward near the base. Internal sac small with fine hairs, but no chitinous armature.

Remarks on *Trogidae*.—The chitinous large median lobe and the comparatively simple internal sac separate the *Trogidae* from the *Copridae* s. b.; *Cloeotus sinuatus*, with its small but distinct median lobe comes near to them, but its sac is large and of a complex shape as in other *Copridae*.

Such a form as *Trox* sp. ? No. 1, approximates to *Mitophyllus* and other allied *Lucanidae*, while *T. omacanthus* leans a little to the *Passalid* aedeagus. *T. scaber* approaches a little to the *Sinodendron* type, but very little.

The small family *Trogidae* is of great importance as regards the classification of the *Scarabaeoid* series of *Coleoptera*, and should receive a thorough anatomical study. We allude to it again under the heading "Taxonomy."

Family PASSALIDAE.

Forms examined: *Proculus opacipennis* Th. and *P. mnizechi* ? Central America. *Eriocnemus* sp. not in Brit. Mus., Mysol. *Protomocoelus* (*Pelops*) *gestroi* Kirsch, New Guinea. *Labienus ptoæ* Kaup, New Guinea. *Nelus* sp., Amazons. *Leptaulacides planus* and *L. vicinus* (in Brit. Mus. Coll.), Sarawak. *Aulacocylus edentulus* MacL., and *A. teres* Perch., Australia.

Figs. 11, 12, 13 and 13a Pl. XLIV.

Leptaulacides planus (Pl. XLIV fig. 11).

Median lobe short and round, with median orifice at end and median foramen at base. Lateral lobes large, rounded at their tips and consolidated together to their extremity on the dorsal side, but still showing the line of junction; on the ventral side they meet together at their base where it is chitinous, and for some little way up where it is membranous (*m*). Basal piece small chitinous all the way round. Internal sac large, twice as long as the aedeagus, with patches of brown hairs.

Labienus ptoæ (Pl. XLIV fig. 12).

Median lobe very large and round, with the median orifice on the dorsal aspect. The lateral lobes are consolidated on the ventral

side and the basal-piece forms a small sclerite placed ventrally, being membranous on the dorsal aspect. Internal sac about twice as long as the aedeagus, covered with fine light spines.

Aulacocyclus edentulus (Pl. XLIV figs. 13 and 13a).

The median lobe is large and round, with the median orifice across the dorsal aspect. The tegmen (*tg*) forms a chitinous tube, narrower at the base than at the apex. The internal sac is a little longer than the aedeagus, the apex studded with light brown short hairs.

The forms that we have examined divide into two distinct groups, in one the tegmen consists of two distinct pieces, the basal-piece and the lateral lobes; in the other (*Aulacocyclus*) the basal-piece and the lateral lobes form one piece, either by consolidation or the suppression of the basal-piece. It is possible that this family is an offshoot of such a form of aedeagus as *Trox omacanthus*, but still more probable that it came from some form annectant with Trogidae and Dynastidae.

Family SCARABAEIDAE.

Forms examined: We have examined somewhat less than 100 forms of this enormous family of Coleoptera. Mr. G. J. Arrow has been so good as to suggest an arrangement of those that call for notice that will be convenient, and in accordance with his views (which, as he states, are to some extent conventional); and we place them under fourteen divisions, as follows:—

1. COPRINAE. *Ateuchus* (or *Scarabaeus*) *cicatricosus* Luc., Spain. *Eucranium lacordairei*, S. America. *Phanaeus lugens* Nevinson, Venezuela. *Helicoprion mouhotus* Sharp, Malay penins. *Catharsius molossus* L., Asia trop. *Onthophagus fracticornis* Pr., Brockenhurst. *Oniticellus* (*Radama*) *marsyas* Ol. Madagascar.

2. APHODIINAE. *Aphodius punctato-sulcatus* St., Brockenhurst, and *A. senegalensis* Kl., Old Calabar. *Millingenia fossor* Sharp, Ismailia. This latter not correctly classified.

3. ACANTHOCERINAE. *Cloeotus sinuatus* Bates, Guatemala, and *C. rugiceps* Germ., Rio de Janeiro.

4. ORPHNINAE. *Orphnus* sp.

5. HYBOSORINAE. *Hybosorus orientalis* Westw., E. India. *Liparochrus timidus*, Arrow, N. Australia.

Anaidcs laticollis Har., Mexico, and *A. simplicollis*, Costa Rica. *Phaeochrous emarginatus* ? Castl., New Guinea.

6. GEOTRUPINAE. *Geotrupes stercorarius* L., Britain; *G. mutator* Marsh., Britain; *G. pyrenaeus* Ch., var. Reynosa. *Typhoeus typhoeus* L., Brockenhurst.

7. ACLOPINAE. *Aclopus* sp., Rio de Janeiro.

8. PACHYPODINAE. *Pachypus cornutus* Ol., Europe.

9. GLAPHYRINAE. *Amphicoma vulpes* Fabr., Caucasus.

10. MELOLONTHINAE. *Microplidius luctuosus*, Natal. *Pyronota edwardsi* Sh., New Zealand. *Hoplia coerulea* L., Pyrenees. *Diphucephala furcata* Guér., Australia. *Maechidius* spp., Australia. *Rhizotrogus solstitialis* L., Britain. *Anoxia orientalis* Kr., Europe. *Melolontha vulgaris* L., England.

11. EUCHIRINAE. *Euchirus longimanus* L., Amboina.

12. RUTELINAE. *Anisoplia floricola* Fabr., Gibraltar. *Phyllopertha horticola* L., Europe. *Spilota reginae* Newm., China. *Anomala assimilis* Boisd., New Guinea. *Mimela confucius* Hope, China. *Oryctomorphus variegatus* Guér., Chile. *Parastasia bimaculata* Guér., Nicobar Islands. *Pelidnota punctata* L., N. America. *Anoplognathus analis* Dalm., and *A. olivieri* Dalm., Australia. *Repsimus manicatus* Sw., Sydney. *Bolax westwoodi* Castl., Brazil. *Fruhstorferia javana* Kolbe, Java.

13. DYNASTINAE. *Hexodon unicolor* Ol., Madagascar. *Cyclocephala stictica* Burm., Mexico. *Ancognatha vulgaris* Arrow, Ecuador. *Phileurus didymus* Er., S. America. *Homophileurus 4-tuberculatus* Beauv., S. America. *Cryptodus* sp. ?, Australia. *Xylotrupes gideon* L., Asia, etc. *Oryctes boas* Fabr., Trop. Africa. *Diloboderus abderus* St., Brazil. *Augosoma centaurus* Fabr., Africa. *Eupatorus hardwicki* Hope, India. *Golofa eacus* Burm., S. America.

14. CETONINAE. *Lomaptera xanthopus* Boisd., New Guinea, and *L.* sp. (not in Brit. Mus.), New Guinea. *Ischiopsopha bifasciata* Q. and G., New Guinea. *Macronota diardi* G. et. P. and *M. suturalis* Voll., Borneo. *Cetonia aurata* L., England. *Diaphonia dorsalis* Newm., Australia. *Inca pulverulentus* Ol., S. America.

Figs. 14 to 28 Pls. XLIV, XLV, and XLVI, also fig. 28 on Pl. XLVII, are devoted to Scarabaeidae.

N.B.—While this memoir is passing through the press, the junior author has been able to make an examination of the male genitalia in the pupa of a species of

Anomala, and he finds that the lateral lobes develop on the ventral aspect. *It follows from this that the orientation we have adopted in the following sketch of this family is incorrect and should be reversed, at any rate as regards the terms dorsal and ventral applied to the aedeagus.*

Ateuchus cicatricosus.

The aedeagus is of the same type as *Phanaeus* and *Helicopris*, etc. It is however strongly chitinated and the lateral lobes are more complex and irregular in form. The internal sac is very remarkable; it is large and complex in shape; at the apex are two long, curved spines closely pressed against one another (looking like one); a little beyond is a small, curved bifurcate, spine-like, chitinous plate; towards the base is a shallowly concave chitinous plate from the apical end of which arises a strong chitinous piece giving off a dozen thin, flattened, curved lamella-like spines which lie together like the lamellae of certain antennae.

Eucranium lacordairei.

Is similar to *Ateuchus cicatricosus* in type, but the sac has only chitinous plates for armature.

Phanaeus lugens.

Median lobe small with chitinous support at base, prolonged into two short, broad, median struts. Lateral lobes small, connected together by membrane to near their tips. Basal-piece large, strongly chitinous, tubular with a large basal opening. Internal sac large, complex, with chitinous structures, one being a broad, curved spine towards apex.

Catharsius molossus.

Median lobe small with a chitinous support continuing as two short median struts for the support of muscles. Lateral lobes large, fairly narrow and curved, joined together on dorsal and ventral side of membrane which folds in when lateral lobes are brought together; this forms a tube in which the median lobe is situated and hidden. Basal-piece large, forming a chitinous tube, slightly bent near base, with basal opening on ventral face. Internal sac large with complex armature; near the base there is a shallow wide diverticulum, about the middle a wide curved chitinous plate, and towards the apex two thin chitinous spines arising from near the opening of the ejaculatory duct; a large spine-shape plate supports the membrane at the base of the two spines.

Helicopris mouhotus.

Median lobe small, entirely hidden and embraced by the lateral lobes. Lateral lobes rather large, with a membranous connection to near their tips, which membrane folds together when the lateral lobes approximate. Basal-piece large, forming an irregular chitinous tube, curved and enlarged at the base, with a large basal opening. Internal sac large, with two blunt, flattened, chitinous spines near apex.

Onthophagus fracticornis.

Median lobe small, with small chitinous support at base projecting into basal-piece as two short, broad, rounded, median processes (cf. *Oniticellus*). Lateral lobes small, connected by membranes to near their tips. Basal-piece large, forming chitinous tube with large basal opening at base. Internal sac large, bearing complex, curved chitinous plates on the apical half.

Oniticellus marsyas.

Tambour cylindrical, basal portion short. Lateral lobes short and powerful, abruptly flexed, of irregular, complicated form; their median aspects contiguous throughout. Median lobe entirely concealed, forming at the base a chitinised tray, basally split for two-fifths of its length and forming a secondary tambour within the normal one. Sac largely developed. This is a very remarkable and high form of Coprinae, though the affinity with *Onthophagus* is a close one.

Obs.—The Coprinae have the basal-piece rather completely tubular in form, owing to the shortening of the basal part of the “tambour.” The basal part of the tambour (or great basal sclerite of the Scarabaeidae) is chitinous on one aspect, membranous on the other, and this basal portion being in Coprinae of small elongation in comparison with the distal portion, the tubular form of the distal portion is unusually conspicuous. The aedeagus of Coprinae is easy of recognition.

Aphodius punctato-sulcatus (Pl. XLV figs. 18 and 18a).

Median lobe small and membranous, supported on the dorsal edges by two chitin strips (*a*) which project into the basal-piece as two struts (*ms*) for the support of muscles; median orifice occupying all the dorsal face. Lateral lobes large, a semi-chitinous extension along the dorsal edges (*b*) form two flanges which overlap and hide the median lobe. Basal-piece large, the distal half forming a tube, the

dorsal part extending backwards, bent and slightly flattened. Internal sac large, its surface covered with chitinous spines, those in the middle being largest and pointed.

Aphodius senegalensis.

Differs but little from the foregoing.

Obs.—If the two *Aphodius* examined by us are characteristic of the group, it is distinguished from Coprinae by the more flat, less cylindric, base of the tambour.

Millingenia fossor.

Median lobe small but well chitinated, without median struts. Lateral lobes slightly longer and pointed, embracing the base of the median lobe but not entirely concealing it, meeting at their base on the dorsal side and connected by a thin strip of chitin on the ventral. The basal-piece large but mostly semi-chitinous. Internal sac medium size with a thin triangular chitinous plate on the dorsal side near base and a strong chitin knob on ventral side near base. This appears to be near to *Cloeotus*. Not correctly placed in Aphodiinae.

Cloeotus sinuatus (Pl. XLIV figs. 15 and 15a).

Median lobe small, of a semi-chitinous nature, but quite distinct; median orifice on ventral side near tip. Lateral lobes little longer than median lobe, not quite meeting together at their bases, embracing the basal-lateral portion of median lobe. Basal-piece very large, forming a curved chitinous sclerite on the ventral side, a large membrane (*m*) separating it from the lateral lobes, except at the lateral corners where the sclerite is prolonged to the lateral lobes (*a*). Internal sac very large and complex, bearing short hairs, but no chitinous armature.

The fact that the basal-piece forms a sclerite on the ventral side of the aedeagus appears to point to a difference between it and the Coprinae, but we must recall what we have previously said about the dorso-ventral aspect.

Cloeotus rugiceps.

Similar to *C. sinuatus*, but the median lobe is smaller, more membranous and more covered by the lateral lobes. Internal sac large and complex, bearing hairs that graduate in certain spots into short stout spines.

Cloeotus appears to form a connection between the Trogidae, in which the median lobe is well developed and

the internal sac small or unspecialised, and the Coprinae, in which the median lobe is entirely hidden between the lateral lobes, much reduced in size and chitinisation, and the internal sac is greatly developed and complex.

Orphnus sp.

Appears to come nearer to *Inca* and *Euchirus* than to *Geotrupes*. The concealed median lobe is large and membranous, with chitinous support at base prolonged into median struts. Lateral lobes large, acutely pointed, curved downwards, and straight on the inner side, dilated near the tips on the outer side, consolidated at base on dorsal and ventral side. Basal-piece large of Melolonthine type, the ventral plate being very slightly chitinised. Internal sac large with short, stout spines about the middle.

Orphnus is very different from Coprinae.

Hybosorus orientalis.

Closely allied to *Phaeochrous*. Median lobe as long as lateral lobes, visible, well chitinised and asymmetrical; no median struts. Lateral lobes asymmetrical, the right being broad at base and bluntly rounded at tip; the left broad at base, the distal three-fourths being thin and narrow; the projection near base on dorsal edge forming a small prong; they do not join at base either on dorsal or ventral side. The basal-piece smaller in proportion than in *Phaeochrous* and not forming a tube, the ventral side being membranous. Internal sac large, studded with short brown chitinous spikes with a patch of dark hairs near middle.

Liparocheirus timidus.

Median lobe small and membranous, the chitin forming two small supports (median supports) projecting into the "basal-piece" for the attachment of muscles. Lateral lobes large and square in shape; meeting at base both on dorsal and ventral sides and entirely covering the median lobe. Basal-piece a long curved sclerite on the dorsal side. Internal sac large and complex, but without chitinous armature.

Anaides laticollis.

Median lobe small, and membranous except for two small supporting sclerites, produced into the basal-piece as two long struts for the support of muscles; these are in close connection with the base of the lateral lobes. Lateral lobes well developed, bluntly pointed and meeting at base on dorsal and ventral

faces. Basal-piece large and curved, situated on ventral (?) side. Internal sac large and complex; surface covered with very short spines with a patch of dark hairs towards the base.

A. simplicollis is very like *A. laticollis* but the sac bears a large curved chitinous plate near base, a patch of spine-like hairs about the middle and another near the apex, the rest of the surface covered with short spines.

In *Clocotus*, *Millengenina*, *Anaides*, *Liparoehrus*, *Hybosorus*, and *Geotrupes* the lateral lobes are free, or only connected together at their bases. In *Aphodius* the lateral lobes have membranous extension along their edges but they are not amalgamated together. In the *Coprinae* the lateral lobes are connected together by membranes and form a more or less complete tube which includes the median lobe.

Phacochrous emarginatus (?) (Pl. XLV figs. 16 and 16a).

Median lobe small but well chitinised; median orifice on ventral side of tip; median foramen large and basally placed. Lateral lobes asymmetrical, the right shorter and broader than the other, concave on inner side at base for the reception of the median lobe; left curved, with projection near base on dorsal edge. Basal-piece large, forming a chitinous tube with a large opening on the ventro-basal part. Internal sac small and simple, covered with brown hair. When at rest the aedeagus lies on its side.

Typhoeus typhoeus (Pl. XLV figs. 17 and 17a).

Median lobe reduced to a small chitin ring (*ml*) projecting into the basal-piece as two median struts (*ms*). Lateral lobes small, but entirely concealing the median lobe. Basal-piece large, forming a chitinous lobe, bent downward near the base, the basal opening large, somewhat dorsal and the edges asymmetrical; the apical ventral margin (*a*) is produced beyond, and conceals, the base of the lateral lobes. Internal sac small, covered with brown hairs.

Geotrupes pyrenaicus, var. from Reynosa; is of the same type as *Typhoeus* but the ventral apical margin is produced as two broad plates which cover the ventral side of the lateral lobes.

In *G. stercorarius*, also the ventral distal edge of the basal-piece is produced into two spatulate lobes which cover the ventral side of the lateral lobe and the dorsal edge is produced into two broad lobes which cover the dorsal surface of the lateral lobes. The lateral lobes are small and asymmetrical. The median lobe is reduced to a membrane supported by the median struts consolidated into one

slender rod, the distal chitinisation being continued on to the internal sac which is small. *G. mutator* is similar to this.

Obs.—*Geotrupes* is very remarkable and distinct. The tambour is very much closed, the basal portion of it is greatly reduced in size and the diameter there is considerably less than at the distal extremity, where the shape is very peculiar. The lateral lobes are of unusual form, and the distal chitinisation of the median lobe is strange, though it differs a good deal according to the species. *Typhocus* is not so extraordinary as the other forms and may represent a distinct genus.

Aclopus sp.

Median lobe membranous. Lateral lobes long, thin and curved, basal half connected together by membrane. Basal-piece tambour-shape, much broader at base than at apex. The only specimen of this form at our disposal is so much damaged that we can say no more about it.

Pachypus cornutus.

Median lobe small, membranous; supported by a chitinous patch on each side, prolonged into long median struts. Lateral lobes fairly large, consolidated together for about one-third from their base on the dorsal side, and on the ventral side with membrane for about two-thirds from their base. Basal-piece large, tambour-shape, slightly flattened and asymmetrical. Internal sac large, covered with minute chitinous, pointed scales.

Amphicomma vulpes (Pl. XLIV fig. 14).

Median lobe small, visible, membranous except at base, with two median struts. Lateral lobes very small, free, their bases not touching on dorsal or ventral side. Basal-piece forming a long, thin, curved, chitinous tube, with basal opening at base on ventral side. Internal sac well developed and complex. It is difficult to distinguish the membranous median lobe from the sac as there is no line of demarcation.

The very long chitin tube formed in this insect by the basal-piece is highly remarkable. In fig. 14 this part is by a lapsus marked *ml* instead of *bp*; but the position of the median lobe is correctly indicated by the other *ml* near the tip.

Microplidius luctuosus (Pl. XLVI fig. 22).

Median lobe internal, fair size, membranous, except along base (*a*) where a chitinous strip runs along edge and projects as two median struts (*ms*). Lateral lobes large and curved near tips, their basal halves connected by membrane. Basal-piece tambour-shape broader at base than at apex. Internal sac well developed without chitinous armature.

Hoplia coerulea.

Basal plate large, broad, asymmetrical; forming a broad chitinous tray, very far from the tubular shape. Lateral lobes very long, their distal portions free; the free parts about as long as the parts connected by the membrane that forms the delicate cylinder through which the median lobe plays. The median lobe shaped like a long delicate finger; membranous, but at its base provided with a delicate, horse-shoe-shaped, semi-ring of chitin, and on the membrane basal to the ring, a pair of extremely fine chitin rods. Sac not observed. The median lobe is in this case extremely mobile and slips backwards and forwards to such an extent as to make it superficially either visible to a considerable extent, or apparently absent.

Diphucephala furcata (Pl. XLV figs. 21, 21*a*).

Median lobe internal, large, membranous, with a thin chitinous support along ventral side (*a*) and base, continued as median struts. Lateral lobes consolidated together for their basal half, the distal portions curved downward, asymmetrical and pressed near together, the right tip coming to a point, the left flattened, expanded, and produced into two short points. Internal sac large without chitinous armature. Basal-piece long and tambour-shape.

Maechidius sp.

Median lobe medium size fairly chitinised, not extending into median struts. Lateral lobes large, consolidated together for about one-fourth from their base. Basal-piece large, chitinous on dorsal (?) aspect entirely membranous on ventral, and as it is remarkably flat, offering no protection there to the softer parts. Internal sac fairly large, covered with fine hair; no chitinous armature.

Pyronota edwardsi.

Basal-piece large, feebly chitinised, on one aspect, and quite without chitinisation on the other. Lateral lobes elongate, bent almost at a right angle a little distance from their base, apically free as far as the bend, basally from that connected by a very

narrow strip of membrane; their inner aspects flattened and adpressed. Median lobe apparently not passing between the lateral lobes.

This is very different from any other of the forms we have examined. The relationship of the median lobe and the lateral lobes would appear to be very unusual, but having only one specimen at our disposal this is not very clear.

Rhizotrogus solstitialis.

Of the same type as *Melolontha*. Median lobe medium size, membranous, supported by two thin sclerites. Lateral lobes large, broad, joined together to near their tips and forming a tube. Basal-piece not quite so long as the lateral lobes, chitinous on dorsal side but membranous on ventral. Internal sac large.

Anoxia orientalis.

Median lobe small, chitinous on each side, with two long median struts. Lateral lobes very large, long and curved at points; on ventral side they are consolidated for about one-fourth of their length near the base; on the dorsal side the basal three-fifths are consolidated together. Basal-piece tambour-like, somewhat shorter than the lateral lobes. Internal sac fair size, no chitinous armature.

Melolontha vulgaris.

Median lobe fair size but membranous, except for a narrow strip of chitin along each side, proceeding into basal-piece as two median struts. Lateral lobes long, narrow, and curved, with the tips slightly expanded; joined together at their base on ventral and dorsal sides with a membranous connection nearly to their tips. Basal-piece tambour-like, forming a large curved sclerite on dorsal side, the ventral side membranous. Internal sac large and complex, covered with small hairs but bearing no chitinous armature.

The student should refer to Straus-Durckheim's immortal work on *Melolontha*. It will give him a good idea of the genital tube in Coleoptera, as well as a knowledge of the details of this species. He uses the term "tambour" for the large basal-piece of the aedeagus, and we have used it also in the sense of a general resemblance to *Melolontha* in the form of this part. The tambour shape does not exist in *Trox*, and *Amphicoma* shows a very great modification of it.

Euchirus longimanus.

Median lobe small, supported by two thin chitin strips near base, continuing into the basal-piece as two median struts. Lateral lobes long, pointed, with the points strongly curved near tips and slightly flattened; connected at base on dorsal and ventral side, otherwise free (no connecting membrane between them). Basal-piece tambour-shape. Internal sac large and complex, covered with short hair, but bearing no chitinous armour.

This curious insect shows no approach to *Amphicoma*; but apparently the aedeagus is but little different from *Aclopus*, and the forms placed early in the Melolonthine series.

Anisoplia floricola.

The lateral lobes are very long, touching for the greater part of their length, but not consolidated together. Basal-piece medium size, tambour-shape, with a small ventral plate. Basal piece and lateral lobes consolidated together, so that their real line of junction is difficult to distinguish. Internal sac without chitinous armature.

Phyllopertha horticola.

The aedeagus is short and broad, and the proportions generally similar to *Anomala*; there appears to be a large chitination of the base of the median lobe.

Spilota regina (Pl. XLV figs. 20 and 20a).

Median lobe normal in shape and size, but the internal sac has a strong chitinous plate armed with spines near the apex (*b*), and has a pair of strong chitinous processes (*a*) on the apex; this armature prevents the sac from being entirely evaginated, and makes it appear to be part of the median lobe. A similar thing takes place in *A. marginipennis*, where the plate bearing spines is very large and looks like the median lobe, and can only be understood by dissecting it away from the tegmen. In *S. regina* the lateral lobes are large and asymmetrical, the left being widened and curved at apex. Basal-piece tambour-shape, with a small ventral plate (*vp*).

Anomala assimilis (Pl. XLV fig. 19).

Median lobe small but distinct, the basal part being chitinated and prolonged into two median struts. Lateral lobes short and broad, meeting together at their bases on the dorsal side (but not consolidated together) and wide apart on the ventral side. Basal-

piece tambour-shape with a chitinous plate (ventral plate, *vp*) on the ventral side at the base of the lateral lobes, to which these are attached by membrane. Internal sac very large and complex; a chitinous plate (*b*) near apex, below it a small patch of hair, three large diverticula, one covered with hair and a slender long diverticulum above it. The opening of the duct (*a*) is on the ventral side.

Mimela confucius is of the same type; the ventral plate of the basal-piece more complex, being curved, and the distal end bilobed (or deeply emarginate) and projecting between the lateral lobes.

Oryctomorphus variegatus.

This is of the same type as *Pelidnota*, the lateral lobes being consolidated on the dorsal side and the tip rounded.

Parastasia bimaculata.

Lateral lobes joined together on dorsal side somewhat as in *Oryctomorphus*, line of consolidation distinctly visible. Basal-piece large, tambour-shape, without a ventral plate.

Pelidnota punctata (Pl. XLVI fig. 23).

Median lobe fair size, membranous, with two small chitinous strips at sides prolonged into two long thin median struts. Lateral lobes consolidated together on the dorsal side, forming a flattened plate, broad at the base, with a bifurcate tip; the ventral edges, even at base, wide apart. Basal-piece broad, flattened, tambour-shape one-third of length; on the ventral side there is a large chitinous plate (ventral plate) covering the apical half of the ventral surface of the basal-piece. Internal sac very large, with five short, broad chitinous teeth about the middle, four being of equal size, the fifth much larger.

Anaplognathus analis and *A. olivieri*.

The *Anaplognathi* are recognised by the elongated lateral lobes, consolidated together on the dorsal side to near their tips, the ventral plate of the tegmen is also elongated and lies between the lateral lobes on the ventral side, thus forming a long tube. *Repsinus* is of the same type but not so specialised, the lateral lobes being shorter and only consolidated along their basal half.

Bolax westwoodi (Pl. XLVI fig. 24).

Median lobe long, thin and membranous, with semi-chitinous supports at the base (*a*). Lateral lobes very small, free, meeting at base on dorsal side but not on ventral, flattened and obtuse at

apex. Basal-piece very large, forming a long tube, the dorsal part formed by a long, curved sclerite and the ventral surface by a long narrow one (*vp*). Internal sac long, thin at apex and supported by a chitin strip (*b*).

Fruhstorferia javana.

At the last moment we have received an example of this remarkable creature. The male structures are so extraordinary that they may be briefly described as having the appearance of being crippled or deformed. The example is however so perfectly developed as regards its external structure that there can be little doubt as to the "deformity" being natural.

The basal portion of the tambour is normal, but beyond this the part is twisted so that the orifice for the protrusion of the median lobe is placed laterally; one of the two lateral lobes forms a very hard, irregular tusk, while the other is membranous, and appears to be merely a useless appendage. The median lobe appears also to be twisted and deformed at the apex, which is slender. There appears to be no line of demarcation between median lobe and sac, and the part just described may be considered to be the everted sac. In that case the lobe is prolonged forwards into the body far beyond the tambour, and is of irregular shape; distally ample, then more slender, and in front of this rendered a little more broad by means of a large horse-shoe-shaped sclerite; in front of this it is again more slender, and contains some apparently semi-chitinised structures extending to the part where it is joined to the duct.

Obs.—The few Rutelina examined display forms that may be group characteristics. *Anisoplia*, *Phyllopertha* and *Anomala* have the lateral lobes free; and they are elongate in *Anisoplia*, short in *Anomala*. In the other forms (except *Bolax*) they are united either at the base or for their whole length. Anoplognathini have the cylinder formed by their conjunction elongated. The extraordinary Asiatic *Fruhstorferia* is quite abnormal by the distorted aedeagus. *Bolax* has a very long tubular basal-piece, with comparatively small, free lateral lobes, and should be compared with Glaphyrinae, though it is probable that the elongate, tubular form of the basal-piece may not be as important as it is remarkable.

Hexodon unicolor (Pl. XLVI figs. 25, 25a).

Median lobe large and membranous, with chitinous sclerites at base, prolonged into median struts (*ms*) consolidated for the

greater part of their length. Lateral lobes large, symmetrical ; consolidated on dorsal and ventral faces at base. Basal-piece large, tambour-shape with a ventral plate (*vp*) connected to the basal ventral edges of the lateral lobes by membrane, not consolidated to them. Internal sac large with four long thin diverticula at apex, covered with hairs, no armature.

We have examined several species of *Hexodon* and find they fall into two groups, one with symmetrical lateral lobes and four diverticula of sac ; the other with asymmetrical lateral lobes and five diverticula.

Ancognatha vulgaris.

Median lobe moderate in size, membranous with chitinous support near base. (In some Scarabaeidae the chitinous support of the median lobe appears to appertain rather to the second connecting membrane, but we have described it as belonging to the median lobe as only a detailed study in many forms could elucidate this.) Basal-piece of the usual tambour-shape, its concave aspect membranous, its dorsal more feebly chitinised than in the normal Dynastinae ; the sides of this sclerite prolonged distally so as to form a point on each side to which are articulated the very peculiar lateral lobes. These, viewed laterally form a sort of V, between the branches of which the distal point of the basal piece (as described above) penetrates. The lateral lobes are not in this species amalgamated by chitin but exist as two sclerites connected by membrane. Viewed on the convex aspect of the aedeagus in repose, the two sclerites become contiguous, their inner margins being nearly straight ; each is a little truncate at the tip, and on the outer side has a small, sharp hook. On the concave aspect, the sclerite is larger than on the other aspect, but the inner margins are parallel here also. These lateral lobes are capable of divarication, and it appears that this permits the extrusion of the median lobe.

Internal sac large and complex, the apical half greatly enlarged, with two small diverticula near opening of ejaculatory duct at apex, and a long thin diverticulum opening near middle ; no chitinous armature, but surface covered with short fine hair.

Cyclocephala stictica.

In this the lateral lobes are greatly abbreviated and form a ring at the end of the basal-piece. This ring, being placed at a right angle to the axis of the aedeagus, is articulated on each side to the distal point of the basal-piece ; except at this spot the connection of the lateral lobes with the basal-piece is entirely membranous. As the ventral plate of the basal piece is to some extent elastic,

the annular lateral lobes can, by it stretching, be brought into the same plane as the axis of the aedeagus.

The soldering together of the tips of the lateral lobes so as to form a perfect ring, make this very different from *Ancognatha*. The two forms have in common the unchitinised ventral plate of the basal-piece.

It should be noticed that in this form the consolidation of the lateral lobes into a ring takes place in an indirect manner. The apices of the lobes meet very nearly, but not quite, and a distinct narrow space is perceived between them; but basally to this small space the ventral plate penetrates between the lobes and is just there strongly chitinised, though elsewhere it is quite membranous.

This is a very interesting case. If we make use of a teleological mode of expression we may say that it appears that the tips of the lateral lobes are in process of becoming consolidated so as to form a structure normal in *Dynastinae* (compare with *X. gideon*). The functional difference between *Ancognatha* and *Cyclocephala* appears to be that in the latter the orifice is held open permanently by the ring-shaped lateral lobes; while in the more Melolonthoid structure of *Ancognatha* the lobes are mobile and the orifice opens or closes as the situation requires.

Cyclocephala would from this point of view appear to be related to *Xylotrupes*, while *Ancognatha* points to an affinity with *Diloboderus*.

Oryctes boas.

The distal portion of the tambour is elongate and cylindrical, the basal portion broad and short. The lateral lobes are long, placed at a right angle with the cylinder, the orifice between them viewed from behind is elongate and rather narrow. The structure at the base of the median lobe is rather perfect; the chitinisation of its anterior part on one aspect is met by a V-shaped prolongation from the other aspect, and by the conjunction of the two a complete ring-encasement is formed. We have already stated that we have not been able to decide as to the nature of this chitinisation.

Diloboderus abderus.

The aedeagus is here short, broad at the base, and gently narrowed to the tip so as to be somewhat conical in form viewed dorsally. The lateral lobes are articulated so as to admit of a

beautiful movement of a limited nature. In repose they are brought near together, and their inner dorsal margins lie parallel though separated by a good space. If a little pressure be applied inside the aedeagus at the point where they meet dorsally, the two lobes separate by a partial rotation and then disclose a broad orifice such as we find to be the fixed position in *Xylotrupes gideon*. The specimen is in very bad condition, but we mention it because we have not observed a similar peculiarity in allied forms, though it may not improbably be found to exist elsewhere in the higher Dynastinae. The form and general proportions of the aedeagus are similar to those of *Oryctes boas*. Some special experiments made with that species show that the lateral lobes can be forced apart to a considerable extent by pressure, but there is no rotation whatever, and the parting is due to the elasticity of the ventral plate connecting the lobes.

Xylotrupes gideon (Pl. XLVI figs. 26, 26a and 26b).

Median lobe large, membranous, with chitinous ring at base for support, prolonged into a pair of median struts, consolidated at their base. Lateral lobes consolidated on dorsal and ventral side, short forming a short ring or tube which projects on the ventral side as two short, flattened and truncate points, which have a slightly outward turn. Though the lobes are thus separated at their distal part, they are united, in front of the free processes, to form a ring. Basal-piece large, tambour-shape, constricted about the middle, with a ventral plate (*vp*) which is only consolidated to the lateral lobes at the corners (*a*).^{*} Internal sac large with two large, strong, curved spines about the middle.

We have examined several specimens of this well-known insect; they come from different localities, and there is slight variation in the aedeagus.

Three males from Koberi (N. Guinea, Pratt), one of them the fullest development of the species, the other two moderate, agree closely except that the largely developed example has the distal portion of the tambour more elongate, and the tusks of the lateral lobes less abruptly turned backwards.

A single specimen from "Australia" (old coll.), is of the broad, robust variety of the species, with broad thoracic horn, and the forks of the cephalic horn strongly developed; it has the aedeagus much as in the moderate Koberi form, but a little shorter and thicker, the

^{*} In fig. 26 the point (*a*) appears to overlap the lateral lobe: this is not correct; "*a*" only reaches the margin of the lateral lobe, and is there conjoined with it,

tusks of the lateral lobes slightly shorter, and the consolidation of the two lobes where they meet in the middle behind the ventral plate very short.

One example (Cochin China, old coll.) of the same development as the two moderate Koberi forms, differs from them in having the ring of the lateral lobes considerably narrower, the tusks a little longer, and separated by an interval of rather different form. The difference from the Koberi high development male is even slighter.

One specimen from Amboina (F. Muir), a small development but not the smallest, has a decidedly different shape of the orifice, which may be described by saying that above it resembles a Gothic arch, while the forms previously mentioned are more like a Norman arch. Still more striking is the fact that the membrane above and in front of this arch is strongly chitinised, quite black, and the ventral plate is extensively chitinised.

One specimen ("Malasia," old coll.) of maximum development as regards cephalic and thoracic armature, but a rather small and slender individual, differs slightly from the Koberi moderate form in having the distal cylinder of the tambour more slender, and as a consequence the orifice between the lateral lobes more contracted; the tusks are a little longer, and the area between them is narrower and of slightly different form.

An individual ("Ter" [nate] Wallace I believe) is of almost the smallest development of the species, being with cephalic horn only about 30 mm. long; it approximates the Amboina individual, but entirely lacks the hard chitinisation of that specimen.

The sac, in these examples, has not been adequately examined, but in the specimen from Cochin China the curious pair of large spines on it appear to be more unequal in size than they are in the others.

Whether any racial distinctions are to be found in these male structures can be decided only by the examination of good series. We see no reason for supposing that any of the distinctions are of specific importance. The extreme chitinisation of the parts in the Amboina individual is remarkable. In it and in the Ternate example the two spines on the sac are nearly of one size.

Augosoma centaurus.

Very like *X. gideon* but the points of the lateral lobes are acute, and pressed together to their tips and turn downwards; the ventral plate of the basal-piece is consolidated to the lateral lobes; the internal sac is large and has no spines, but has at least one long diverticulum. The conjoined struts at the base of the

median lobe have, attached to each one, a slender tendon, 10 mm. long, and elastic, like india-rubber.

Eupatorus hardwicki.

Is very like *A. centaurus*, but the points of the lateral lobes are longer and slightly spatulate at tips, the opening between the lateral lobes is much narrower. The chitinous developments are comparatively small, the ventral plate being feebly chitinised. We see no remarkable structures on the sac or median lobe, but the only individual at our disposal is in very bad preservation.

Golofa eacus.

Basal portion of tambour large and convex, the distal portion not quite so long as the basal, not cylindric but a good deal flattened. The lateral lobes very remarkable; strongly deflexed, each at the base on the dorsal side developed into a plate, meeting the other and so forming a roof over the base of the orifice; furnished at the apex each with two patches of hair one of which projects beyond the tip, while the other forms a large, very dense patch on the inner and ventral aspect. The ventral plate peculiar, very strongly chitinised, and prolonged as far backwards as the patch of hairs described above, and visible between the apical parts of the lateral lobes as a free edge. Sac elongate and of contorted form, but no armature has been detected.

The specimen was in very bad preservation. The prolonged fold of the ventral plate is remarkable; it limits and shapes the orifice through which the median lobe is protruded.

Homophileurus 4-tuberculatus.

Median lobe large, membranous, the chitinous support at base produced into median struts. Lateral lobes very long, turned downwards nearly at right angles to the basal-piece, the tips slightly curved and spatulate, the inner margins parallel, contiguous distally, slightly separated basally. Basal-piece large, tambour-shape, constricted near the middle, the basal part being greatly widened with a ventral plate moderately chitinised distally, to which the lateral lobes are fastened, but not consolidated. Internal sac large with several long diverticula at apex, covered with hair, but with no other armature.

Phileurus didymus.

This is strikingly different from *H. 4-tuberculatus*. The basal-piece is elongate, but it is subcylindric, and the lateral lobes are

very complex and remarkable. Though they are free, they form a ring, the transverse diameter of which is broad, the free extremities are greatly dilated and one much overlaps the other; moreover each is provided at the base with a large free lobe, projecting in tongue-like shape. This is a very peculiar aedeagus.

Cryptodus sp. ?

Median lobe small, membranous. Lateral lobes large, curved and spatulate at tips, meeting together on dorsal side at base, but not on ventral side. Basal-piece tambour-shape, with a ventral plate consisting of two chitinous sclerites which are consolidated with the ventral edges of the base of the lateral lobes. Internal sac large bearing a complex chitinous armature near apex, of a symmetrical and beautiful shape.

Lomaptera xanthopus (Pl. XLVI fig. 27).

Median lobe well developed but with exceedingly small chitinous support and no median struts. Lateral lobes medium size, consolidated to their truncate tips on the ventral side, and at their base on the dorsal side. Articulated in a central position on the dorsal side of the consolidated lateral lobes is an elastic tongue (*a*) which rises and falls with the evagination and invagination of the internal sac. The basal-piece is large and of the tambour type but with the basal portion short; with a ventral plate (*vp*), rather broad, but not very hard, and not consolidated to the lateral lobes. Internal sac large, without armature; the opening of duct being situated at distal end on a small prominence, with a small papilla on each side (*c*).

In *Lomaptera* sp. ? (small sp. elytra yellow with strong green reflections; not in Brit. Mus. Coll.), the lateral lobes are more slender, pointed and turned down ventrally; the tongue is slender and not articulated at its base but forming a continuous piece with the lateral lobes.

Lomaptera sp. ? Arfak (chocolate elytra). In this species the tongue is broad, and is bifid at the apex. The ventral plate is very remarkable, being connected distally with the lateral lobes by a large, very hard chitination. There is a great deal of hair on the ventral aspect of the lateral lobes. We have this species named *L. ciocolatina* but do not know whether it has been described. It is one of the numerous species discovered by the Pratts.

Ischiopsopha bifasciata.

Differs very strongly from *Lomaptera*. The basal part of the tambour is still more reduced; there is no chitination of the ventral plate. The lateral lobes form a slender ring with a small

notch in the tip at the middle, and there is no tongue. The absence of chitinisation on the ventral aspect appears in this form to be complete; and the approximation to *Cyclocephala stictica* to be incontrovertible.

Diaphonia dorsalis.

The tambour is pretty much of the usual tambour-shape, the basal part being moderately large. The lateral lobes form two free, pointed tusks, and at the base between them there is a large, grooved, triangular process which is strongly chitinised. The chitinisation of the ventral plate is very feeble.

Macronota diardi and *M. suturalis.*

In these two species although the wall of the body is very hard, this is not the case with the aedeagus. The tambour is but little basket-like, and the chitinisation throughout allows the harder parts to be somewhat elastic.

In *M. suturalis* the tambour is remarkably flat, and is not broader at its front. The lateral lobes are short, broad and pointed, and can be brought together in the median line, then forming a roof without special orifice for the protrusion of the median lobe.

In *M. diardi* the tambour is greatly expanded in front, so that its angles descend and are very acute: only the lateral and anterior margins are strongly chitinised, the rest of the surface being feeble and transparent. The lateral lobes are large and complex, each terminating as a spinose process directed outwards, while near the base of each there is a smaller, hooked spine. The position of the two lobes is much the same as in *M. suturalis*. In both species the median lobe appears to be less developed than usual: but both the examples are in a very decayed state.

Cetonia aurata (Pl. XLVII fig. 28).

Tambour elongate but not highly developed, the basal part as long as the distal. Chitinisation of the ventral aspect poor and irregular, there being several patches of inferior chitinisation. The lateral lobes large but not quite so long as the basal-piece. They are placed dorsally with their median margins parallel, but not quite contiguous; they are consolidated for more than half their length, the apical portions being free; the deflexed tips bear each a small process abruptly turned outwards.

Inca pulverulentus.

Median lobe and internal sac not examined. Lateral lobe large, curved downwards, flattened and spatulate at tips; consolidated at

base on dorsal and ventral side. Basal-piece slightly shorter than lateral lobes.

The specimen at our disposal is greatly destroyed by *Anthrenus*. The elongation of the lateral lobes is remarkable. Burmeister considered this form to be related to *Enchirus*, and there appears to be a great similarity in the aedeagus of the two, but we cannot say to what extent this is true of anything but the hard sclerites. The general shape of the aedeagus is one that is frequent in the Melolonthine series of genera.

Obs.—The aedeagus of Scarabaeidae is readily recognised (if Trogidae, Lucanidae and Passalidae are excluded) by the following definitions:—

Tegmen greatly developed, the basal-piece enormous, consisting of an anterior part unchitinised beneath, and a more distal tubular part to which are attached apically the varied lateral lobes (frequently called forceps or parameres); the median lobe drawn within the basal-piece, and thus concealed, membranous except at the extreme base where there are, more or less well developed, elastic chitinous supports; sac large, frequently provided with remarkable, varied chitinous structures.

The perfection attained varies greatly. There are higher and lower forms in each of the great divisions. The number of forms examined is not sufficient to enable us to follow up this remark profitably.

MORPHOLOGY.

B. GENERAL.

A BRIEF statement of the anatomical terms we have used will be found in the early portion of the Memoir (Orismology, p. 481). The term genital tube is used because it conveys the idea of the chief characteristic of the parts. Whatever else they may be, however different they may appear, their combination to form a perfect tube without orifices, is remarkable: the one "orifice" that exists is not a real one. It arises from the invagination of the tube into itself. The genital tube is therefore a doubled tube, one end of which is a continuation of the body wall, while the other divides into a fork, of which one

branch proceeds to each testis. In a peculiar structure of this kind it is evident that the homologisation of the parts is attended with some special difficulties. Extensibility and retractibility of the tube are carried to an extraordinary perfection, and the length of the tube is in some cases enormous compared with the size of the creature, and yet the "orifice" may in one position of the organ be placed near the distal, in another position near the proximal extremity. The same "orifice" is in fact at one moment of the creature's existence placed inside and quite near to the centre of the body, while at another moment it may be placed far away, at the extremity of the extended tube. The walls of this protean structure become in some places hard, and form sclerites. The study of these sclerites is one of the chief aids in our endeavour to understand the changes the tube may have undergone during its evolution.

The homologies of the various parts of the male genital tube are, within certain limits, very easy to follow, and even in some of the most extreme forms can be made out by anatomical comparison. But beyond the limits we have alluded to, the questions become very difficult, and will really only be settled by studies of the ontogeny that at present are not forthcoming. As misconception has been, and still is prevalent to a considerable extent, there are a few general points to which we must allude. According to our view the genital tube commences where the body wall ends. Anatomically it is not easy to decide where that spot is, because body wall and genital tube are continuous.

Embryologists consider with good reason that the stomodaeum and proctodaeum are the poles of the body wall, therefore all parts that have their origin on the dorsal aspect of these openings are tergal, and all parts on the ventral aspect are sternal. The genital tube, being ventral of the anus, can therefore contain no tergal parts; though one or more sternites may enter into its composition.

Hopkins* considers our tegmen in *Pissodes* as "representing the apodeme of the ninth tergite." Bugnion† considers that in *Cissites testaceus* the median lobe ("gouttière interne") is derived from the ninth segment, and the tegmen ("gouttière externe") from the tenth segment.

* U. S. Dept. Agr. Technical Series, No. 20, Part I, 1911.

† Bull. Soc. Ent. d'Egypte, 4^{me} Fascicule, 1910.

We cannot agree with these interpretations without proof from studies of the development.

The question as to a sternite, or part of a sternite, being included in the male genital tube leads to the consideration of the number of abdominal segments, a subject beyond the scope of this memoir. The following points, however, bear upon it. In the majority of beetles the first tergite is often entirely membranous, and the first, second, and, sometimes, the third sternites are also membranous: beyond these the segments are distinct, and, in many cases, there appears to be one sternite missing.

In *Enarsus bakewellii* (fig. 92*b*) there is a distinct ventral plate between the anus and the aedeagus, and in *Cupes clathratus* (fig. 104–104*b*) there is a pair of sub-anal appendages. These facts seem to indicate that there exists in some cases a sternite between the anus and aedeagus although it is only represented by membrane in so many forms.

We have not been able to find the eleventh (Berlese) sternite in *Lucanus cervus*. In this species, as in a great number of others, the rectum is capable of being evaginated. In some cases the rectum has chitinous supports to facilitate this process. In the larvae of many of the Cassidae the rectum is quite telescopic, and is thrust out and turned up to enable the larva to fasten filaments of excrement to its back. If any part of the aedeagus is of chroötic (pertaining to the body wall*) origin it is the tegmen, which in that case is derived from one of the sternites. When a sclerite of the genital tube exterior to (or anterior to) the tegmen exists it may probably be of chroötic nature.

The only observation as to development that we can at present contribute to this discussion is a slight one on a Cistelid. In the larva of *Cistela* (*Eryx*) *atra* there are nine distinct tergites and sternites, the ninth sternite bearing a pair of small papilla-like processes; in the pupa there are also nine distinct tergites and sternites, and the ninth sternite bears the pair of papillae; in the female imago the genital styles are direct continuations of these papillae on the ninth sternite, and they lie within them at the end of the pupal stage.

* We have introduced this term because the more correct word, somatic, has already a wider meaning, as opposed to the germinal tissue or plasma.

Our limited material did not show us the development of the male parts; but in the imago there are nine distinct tergites and eight distinct sternites, the ninth sternite appearing to be represented by a Y-shaped sclerite (fig. 234). A large amount of dechitinisation has apparently taken place at the apex of the abdomen, as well as at the base, and it is possible that some part of the large membranes at the apex (*i. e.* at the base of the genital tube) may represent sternites.

We divide the genital tube into the following parts. A pair of seminal ducts leading from the testes forms the zygotic portion (fig. 239 *a-b*), and the long, single, highly irregular tube, folded back and joined to the body wall, forms the azygotic portion (fig. 239 *b-d*, 5-1). The paired, or zygotic portion (*a-b*), along with certain glands opening into it, is considered to be of mesodermic origin,* and the azygotic, along with certain glands, of ectodermic origin. Bordas† points out that very little is known as to the origin of these glands, and consequently objects to the terms ectadenia and mesodenia applied to them by Escherich, and calls them accessory, or annexed glands. We are not concerned with them here.

The first part of the azygotic portion of the genital tube (fig. 239 *b-c*) consists of a long, more or less slender, tube (the stenazygotic portion); beyond this the tube enlarges and forms the eurazygotic portion (*c-d* and 5-1). In many cases this enlargement of the azygotic portion of the tube takes place before it is reflected outwards to continue its course to join the body wall. We call that portion of the eurazygos that is usually not external (*c-d*), the "internal sac" ("sac interne" of Jeannel).

In all cases that we have observed the internal sac is evaginated during copulation, and forms a continuation of the external parts of the genital tube. In a great number of forms there is no demarcation between the stenazygotic and the eurazygotic portions of the tube before the outward reflection above mentioned; in such cases we say that the internal sac is undifferentiated. That portion of the tube that is reflected and thus forms the external portion of the organ we call phallic. But we

* On this subject see Escherich, *Zeitschr. wiss. Zool.* lvii, 1893, p. 620.

† Bordas, *Ann. Soc. Ent. France*, lxxviii, 1899, p. 510.

must admit that the term is not a good one. The part in question is highly complex. It is in fact the layer, or layers, of the tube of which sclerites of the aedeagus form a large, or the larger, part.

The sclerites on the phallic portion of the genital tube form two groups. (1) Those situate on the distal portion of the tube (furthest from the body wall), which we call the median lobe (fig. 239, 5-4), and (2) those situate nearer the base, which we call the tegmen (3-2). The membrane between these two groups of sclerites we term the first connecting membrane (4-3), and the membrane at the base, joining on to the body wall, we term the second connecting membrane (2-1). The median lobe, together with the tegmen, we term the aedeagus.

The point where the genital tube is reversed (5-*d*) we call the median orifice, and the lumen at the base of the median lobe (4-to corresponding spot below) we call the median foramen. Similar terms could be applied to the tegmen, but we have not found them necessary for our descriptions.

Having thus given a description of the four parts of the tube, we now give remarks as to the structures of each of the four divisions.

The second connecting membrane (or prephallic portion of the tube) varies in extent according to the size and shape of the aedeagus. In certain cases (i. e. *Laccobius* and *Sphenophorus*) it is chitinised in part, and forms a covering round the aedeagus. At, or near, the base there is in many forms a chitinous rod with one or two prongs at the end, embedded in the membrane. This is the "Stengel" of Lindemann, "Rod" or "fork" of Hopkins, and "Spiculum gastrale" of Verhoeff. Hopkins considers it as representing the ninth sternite. A comparison of this in the various families would be of great interest, but would entail a study of the body segments, a task beyond the scope of this memoir. We have therefore left it out of consideration.

The phallic portion of the tube is the one that has chiefly attracted the attention of coleopterists. It consists partly of membrane, partly of sclerites, and there may be most extreme differences in the chitinisation of its different parts, excessively hard chitin being continuous with delicate membrane. We have already explained that we call the sclerites in question the aedeagus, and that this consists of two parts, viz. median lobe and tegmen.

In the vast majority of cases the median lobe is well developed and quite distinct from the tegmen. In the more generalised (or trilobe) form it is well developed, and more or less tubular, with the median orifice situate on the distal extremity, and the median foramen at the basal extremity. In many trilobe forms it is articulated to the lateral lobes by a more or less distinct condyle on the dorsal side of the median foramen; in such cases the first connecting membrane (*cm* 1) is short, and the median lobe can only turn upon its point of articulation (*pa*). A pair of median struts are often attached to the base of the median lobe to give support to the muscles that actuate it. In the Scarabaeidae the median lobe is comparatively reduced in chitination, and often in size, and in the more highly evolved forms the tegmen entirely envelopes and conceals it. In the Tenebrionid type the reduction of the median lobe reaches its maximum; in some of their forms it is only represented by a small membrane on which the median orifice is placed. The line of evolution of the median lobe in the Staphylinidae is from a tubular form, with a basally placed median foramen, to a bulbous form, with the median foramen placed nearer to the median orifice. This reaches its maximum development in *Xantholinus*. In the Cucujoidea group and in the Phytophagoidea the median lobe is generally tubular (at any rate on the distal portion), and the first connecting membrane long, so as to allow the median lobe a large amount of play through the more or less ring-like tegmen.

The tegmen, in the more generalised groups, consists of two parts, the basal-piece, and a pair of lateral lobes. The chitination of the basal-piece then often forms a shield-shaped plate on the ventral aspect, the dorsal aspect being membranous. Unless the chitination forms a complete tube the membranous dorsal part and the second connecting membrane are indistinguishable. The lateral lobes in their generalised form consist of a pair of more or less pointed lateral organs, their outer surface being continuous with the basal-piece, their inner surface connecting to the base of the median lobe, and their position being that they lie one on each side of the median lobe.

In position, size and form the lateral lobes differ so much in various families that their true homology in the different groups will probably be only settled after tracing their modifications through long series of forms, and by studying

their ontogeny. It will be noticed that they are paired, or longitudinal, in arrangement, whereas the other structures of the phallic part of the tube are single and transversely separated. This paired condition of the lateral lobes tempts one strongly to identify any paired processes on the phallic division of the tube (even when median) as being lateral lobes. And it is probable that we and others have too readily succumbed to this temptation.

It is in connection with this point that the term tegmen becomes very useful, for we can homologise the combination more certainly than we can the lateral lobes alone.

The difference in position of the lateral lobes may be accompanied by their partial (or complete?) consolidation. If the chitinisation of the basal parts of the lobes extend towards the longitudinal middle line of the tube at the expense of the membranous creases that exist, the two lateral lobes can become joined, and it is possible that the conjunction may go so far as to obliterate their primitive duality. This consolidation can occur either dorsally or ventrally, and we must look on a distinction so established (as has been pointed out by Verhoeff) as of great importance. It creates a difficulty in adjusting the position of various forms of "*Heteromera*," *Cioidae*, etc.

Extension transversely of conjoined lateral lobes might lead to the formation of a tubular chitinous sheath such as we find in *Trogositidae*, *Cleridae*, *Byturidae*. Or such a sheath might be formed by unconjoined lobes extending both above and below, and if a sheath be formed, by abbreviation it may become a "ring." Or a ring may be formed by extension of the angles, or margins of the basal-piece. We can only briefly indicate some of the numerous modifications that are possible of these phallic sclerites.

In *Staphylinidae* the part of the tube wall that is in so many families chitinised to form the basal-piece, remains membranous, and in other families of the *Staphylinodea* the basal-piece is small. In *Tenebrionoidea* the basal-piece is long, and usually forms the chief part of the aedeagus.

Some morphologists have supposed (as we have already said) that the lateral lobes are modified abdominal appendages; on the other hand it may be suggested that some *Coleoptera* have never possessed lateral lobes. This point is briefly discussed in the section of phylogeny.

The internal sac varies in size, shape and armature in

the different groups, and even in allied species. In the Scarabaeidae it is nearly always excessively large, and is often produced into long diverticula (i. e. *Hexodon*, fig. 25a). In Lucanidae it is found in every stage, from a simple form, in which it is scarcely distinguishable from the stenazygos, to a form such as *Lucanus cervus* (fig. 8). In this species the internal sac is not drawn into the median lobe, but when at rest it is folded down on to the broad median lobe. The sac is produced into a long flagellum, supported on each side by a thin strip of chitin; the stenazygos* continues through the flagellum to its tip. To obtain a similar position of the orifice in Cerambycidae the great sac must be completely everted.

The phenomenon of the internal sac being permanently everted is not confined to the Lucanidae, but appears among the Scarabeidae, Heteroceridae and Lycidae. In *Spilota regina* (fig. 20) the armature of the sac consists of two strong chitinous projections from the apex, and a strong chitinous plate beset with stout spines, the basal part of the sac being membranous. A comparison with allied forms demonstrates that these structures are part of the internal sac, and that the median lobe is normal in shape and size. In *Metriorrhynchus* (fig. 186) there is no doubt as to the everted condition of the internal sac, and it may be doubted whether its invagination is possible in some of these cases.

The flagellum appears in various conditions, as to size, etc., in different families or portions of families. In the Brentidae it reaches an enormous length and fineness, and at the base the stenazygos can be seen running into the flagellum, but further on they appear to amalgamate, as we cannot separate them. Among the Staphylinidae *Pinophilus rectus* has an enormous flagellum coiled up within the median lobe. The other forms of armature situated on the internal sac are very various, and have been described in many species in the special anatomical part of this memoir; cf. various species of *Donacia* (fig. 199), and *Carpophagus* (fig. 204a).

In another portion of this memoir we show that in many

* In the special anatomical portion of this memoir we have always spoken of this stenazygotic portion of the tube as the "ejaculatory duct," but this is a functional term, and by other writers is often applied to the internal sac; it would probably be well to abandon it.

of the types the internal sac is everted during copulation, and it is probable that this method is the usual one; though the Cerambycidae may be peculiar in their mode of eversion.

In a great many forms the line of demarcation between the internal sac and the median lobe is obscured, for in some cases the chitination of the median lobe is continued on to the internal sac, and in others the distal end of the median lobe is membranous. The fact that in many cases the basal portion of the sac, and in other cases the whole sac, is permanently evaginated prevents us from distinguishing the two portions by their positions when at rest.*

Of the zygotic portion of the genital tube we do not speak, as it is beyond the scope of this memoir. And the stenazygos only concerns us because in many forms it is impossible to sharply define it from the eurazygos, before the latter is reflected to form the phallic portion of the tube. In such forms we speak of the internal sac being undifferentiated (i.e. *Hydrophilus*). In cases where the internal sac is differentiated it is sharply defined from the stenazygos by its size, and often by chitinations situated on the sac at the point of juncture of the two parts.

In *Eumolpus* and *Chrysochus* the stenazygos forms a very long slender structure like a flagellum.

Bordas† has pointed out the existence of two completely separated ejaculatory ducts in certain Longicorns (*Lamia*, *Batocera*, etc.). We have also observed this fact in some *Monohammus*, *Gnoma*, etc. Bordas considers that this furnishes an argument in favour of the theory that the terminal parts of the canal were primitively of paired origin. It is possible, however, that this feature is of secondary origin, brought about by the abbreviation and suppression of the stenazygos and the lengthening of the zygotic portions, thus causing the zygotic portions to open into the eurazygos; in some *Monohammus* there is a short stenazygos (fig. 221a).

* Since this was written one of the writers, F. Muir, has observed the development of the aedeagus in *Sphenophorus obscurus*. The median lobe and internal sac arise as a single tube which eventually differentiates into these two portions, the internal sac not being invaginated into the median lobe until the pupa is fully developed and ready to emerge. In many forms, as we have remarked, no distinct line of demarcation ever appears.

† C.R. Ass. franc. av. Sci., 1899, p. 540.

IV. FUNCTION.

Although a knowledge of the functions of the different parts of the male genitalia is essential to a comprehension of our subject, yet knowledge is at present so little advanced that we can here offer to the student only a general statement and a few suggestions.

The matter for the starting of a new generation is prepared in the centres of the bodies of two separate individuals, and it is necessary that the two essences should be brought together. This of course is effected in the *Insecta* by copula. During the copula an unobstructed road must exist. This is the genital conduit, and is formed in part by the genital tube of the male and in part by the genital tube of the female. These structures of two different individuals form functionally a single organ. The sex structures are unique in this respect. And they are not correlative with the life of the individuals, but with the life of the generations.

The importance of a correlative knowledge of the genital tube of the female is absolute, but from the point of view we take there is but little information.

The female *Coleopteron* is usually (possibly always) provided with a spermatheca—a special vessel for the reception of the matter transmitted along the male genital tube. It would appear that this spermatheca is generally placed near the base of the azygotic portion of the female genital tube.

The male structures are therefore directed to the object of placing the sperm in the spermatheca. The first question that arises is as to whether this is accomplished directly or indirectly. Must the sperm be deposited directly in the spermatheca? Or is it sufficient that it be placed in some other part of the female tube?

No positive answer can be given to this question at present. It appears from the vague remarks that one finds in literature that the general idea is that the placing of the sperm in any portion of the female tube is adequate. The opinion we ourselves entertain is, however, the reverse of this. We incline to the view that in a large number of cases, the male structures actually place the sperm in the spermatheca, however remote that structure may be from the orifice of the genital tube of the female. The flagellum

appears to be an organ admirably adapted for this purpose, and its occurrence and reoccurrence in so many isolated forms is, to say the least, highly suggestive. Even in cases where there is no true flagellum, it may well be the case that the functional orifice of the male (not to be confounded with our "median orifice") is applied to the orifice of the spermatheca. See on this point our figures 58 and 63.

Certainty as to this point can only be obtained by repeated observations of the genital tube during its functional activity, and as to this we have been able to make but few observations.

In *Rhagonycha fulva* ♂ the sac is large and rounded, with three pairs of diverticula along the posterior surface, and a large patch of strong spines on the ventral side (fig. 237a, a); the duct opens between the most dorsal pair of diverticula. During copulation this sac distends the uterus to its own size, and the patch of spines covers the entrance to the oviducts. The abundance of this species would make it a convenient form to work out all the details of copulation on.

Unfortunately the process of killing the insects causes the muscles that actuate the internal sac to relax or contract, and so the exact relations of the sac and the female parts are never fully revealed. The shape of the female parts does not exactly correspond to the shape of the male sac and all its diverticula, etc., but there is a co-relationship between them, and apparently they always take up the same position in any one species. Besides the direct evidence as to the importance of the internal sac and its evagination during coition there is the great mass of indirect evidence afforded by the complex armatures that are developed upon them, especially at the apex. In *Pissodes* Hopkins* calls this armature the "seminal valve," but in the various examples of the different families that we have examined the armature does not function as a valve. In cases where there is no differentiated internal sac it is difficult to state how much of the duct is evaginated, but judging by observations made on certain Hydrophilidae a large amount is turned out. The evagination is done, at any rate in part, by blood pressure, and the invagination by the contraction of muscles attached to certain points on the internal sac and to the median lobe.

* U.S. Dept. Agr. Technical Series, No. 20, part I, 1911.

In certain forms the median lobe is specially contrived to effect this blood pressure. In *Xantholinus* the median lobe forms a chitinous egg-shaped chamber, having a membranous band round the middle; muscles pass from the dorsal chitinous portion to the ventral chitinous portion. The contraction of these muscles causes the chitinous portions to approach one another, and thus exert pressure on the fluid in the bulb which forces out the long internal sac. In the case of *Pinophilus* where the sac is exceedingly long, and lies coiled up, with a chitinous flagellum running right through it like a spring, it is not likely that the sac is evaginated; in fact, the chitinisations on its base prevent such a thing. In this case muscular contraction round the coiled sac causes the distal end of the flagellum to be thrust out through the median orifice, the chitinisations on the base of the sac acting as a guide; upon the relaxation of the muscles the flagellum acts as a spring, the coils distend, and the distal end of the flagellum is retracted.

The action of the flagellum is obscure, but the fact that it appears in such diverse families denotes its great functional importance. It would be of great interest if some one would take any form in which this structure is greatly developed (e. g. *Lucanidae*, *Brenthidae*) and kill while in copula and dissect the female, to see if any part of the internal sac is evaginated, and to what part of the female genital tube the flagellum penetrates.*

In the Longicorns the capacious sac is very long, and it seems improbable that it is entirely evaginated, but only direct observation will decide this point.

The various spines and hairs that are found on the sac are generally pointed basally; this prevents the sac being withdrawn from the uterus of the female while the sac is distended. The various diverticula found on the sac do not appear to correspond to diverticula in the female, but they take up constant positions, and may serve as pads to

* Since writing the above one of the writers, F. Muir, has observed the copulation of *Cryptomorpha desjardinsi*. This is a Cucujus-type with a ring-shaped tegmen with a pair of lateral lobes, a long internal sac with a very long and slender flagellum. In this species the whole of the long internal sac is evaginated and enters the long female tube, the flagellum proceeding still further into the female genital tube. The spermatheca is small and attached to the uterus by a long slender duct. Whether the flagellum actually traverses this duct and penetrates the receptaculum he was not able to observe.

keep open certain spaces between the sac and the wall of the female tubes. Observations on the positions taken up by the sacs within the vagina during copulation are greatly to be desired.

The pressure necessary to drive the viscid fluid from the testes through the long slender ducts must be very great, and the thick coating of muscles surrounding the ducts serves to this end. The pressure behind such a flagellum as is found in *Baryrhynchus miles*, where it is 12 mm. long, and .006 mm. in outside diameter toward the tips, must be well directed and considerable.

It is worthy of note that the armature of the sac of *Donacia sericea*, etc., recalls the parts of the aedeagus, there being a median lobe, through which the ejaculatory duct passes, and opens on its apex, and a pair of lateral lobes. There is, as it were, a secondary aedeagus within the aedeagus. To find out the action of these pieces during copulation would be of interest.

Whether the lateral lobes in such a trilobe form as *Ceratognathus* pass into the vagina and then diverge and thus hold the female, we are unable to say. In *Stenus speculator* (fig. 232) the lateral lobes are placed along the outside and hold the female. In Coccinellidae they are placed on the outside of the female venter, and appear to have no hold. In some of the Cistelidae the hind body-segment is developed into claspers to retain the female. In *Malthodes* (fig. 233) and *Malthinus* (fig. 235) the last abdominal segment is used as a clasper, and the last segments of the females have depressions into which the ends of the claspers fit to give them a firmer hold. In *Telephorus* and *Rhagonycha* the edge of the vagina is held between the tongue of the tegmen (fig. 236a) and the median lobe. In these species the aedeagus takes nearly a half turn during copulation (fig. 238). The twisting of the aedeagus during copulation is common to many forms, and in some it makes a complete half turn. This is the case in the Caraboid type. In such an one as *Dytiscus punctulatus* the aedeagus, when at rest and drawn into the abdomen, lies on its side, and when thrust out the median lobe curves downwards, but its true orientation is with the median lobe curved upward as we figure it (fig. 37).

It is probable that in many forms the female does not play an entirely passive part in the act of copulation; as to which see the remark made under *Cyphon*.

We may conclude these very fragmentary observations by pointing out that the diversity of the structures indicates a considerable variety of functional detail.

V. TAXONOMY AND PHYLOGENY.

TAXONOMY.

It has been supposed that the copulatory structures are bad guides in classification, although they are generally admitted to be of the first importance for the discrimination of species. If, however, the extreme importance of the genital conduit be seized, it will appear that its structure must certainly be of very great assistance in taxonomy.

We have in this memoir considered the male portion only of the genital conduit, and that in a very imperfect manner. It seems possible that if the female part of the conduit were studied important distinctions would be found therein. The only considerable contribution to this subject we are acquainted with is the work of Stein (*Mon. Geschl., Organe, etc.*). This was published sixty years ago, and was not specially directed to the consideration of the conduit, but so far as we can form an opinion from it, and from our own limited observations and a few other memoirs, the probability of important differences in the female structures is confirmed.

Under these circumstances it will be suggested that we are not justified in making taxonomical generalisations on the subject of the genital conduit at present. With that suggestion we entirely concur. Nevertheless, as taxonomy has been carried on with little or no consideration of this important branch of anatomy, we think it important to introduce this subject, notwithstanding the very incomplete state of our knowledge.

The generalisations that follow are, it will be seen, imperfect and unsatisfactory. Possibly wider inquiry may bring to light important distinctions we have failed to appreciate, and it is also probable—we may say certain—that such inquiry would reveal the existence of annectant forms we are unacquainted with. As a further apology for the following generalisations we may ask that it shall be remembered that the other data of Coleopterous taxonomy are also very incomplete.

We have omitted from our tentative tables certain families that we have examined, e.g. Trichopterygidae and Discolomidae, but we have been somewhat inconsistent, inasmuch as we have inserted others that are perhaps quite as doubtful. Any one who will examine such forms as *Cerylon* will appreciate the difficulty as to making a correct conclusion as to the morphology of the aedeagus in these exceptional cases; the examination of a series of allied forms is often imperative before coming to a positive conclusion.

We must also reiterate here what we have said elsewhere as to the "Spicule." This is scarcely touched on by us, because it would have involved us in the consideration of the number of abdominal segments; but we recognise the importance of the subject. A comparative study of this sclerite, together with the terminal body segments, is necessary before a final decision can be reached for taxonomical purposes.

At present we are disposed to adopt eight series. We have considered the possible relations of these series in the section on phylogeny.

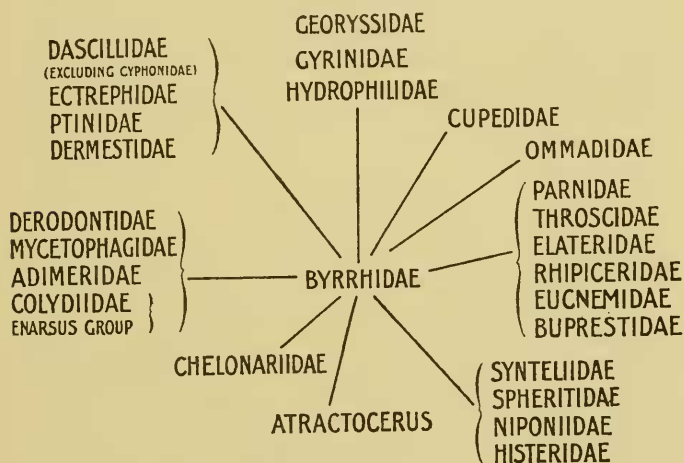
(1) BYRRHOIDEA.

Under this name we include twenty or thirty families. The complex is of considerable importance, as it is possible to consider that we are here in the presence of the more primitive of the conditions of the Coleopterous genital tube, so far as existing forms are concerned. We use this qualification because the structures are very far from being truly primitive. The peculiarities of this complex may be thus summarised, viz.: A median lobe, bearing (as in other cases) the orifice of the duct, and on each side of it a lateral lobe, the sclerites being intimately connected with a basal-piece. The tegmen is thus very complete, and the relation between it and the median lobe is one that allows of very little movement backwards and forwards of the median lobe independent of the tegmen. This distinguishes the families from the Cucujoidea. Moreover, the sac is never highly specialised, in many cases is scarcely differentiated from the duct.

The Buprestidae are peculiar, possessing a remarkable coadaptation between the inner aspects of the lateral lobes and the median lobe, which permits the median lobe to glide backwards and forwards in the slots of the lateral

lobes. This coadaptation is carried to a most beautiful extent in *Euchroma*, but it is imperfect in some of the other forms, and, on the other hand, an imperfect condition of a similar kind obtains in Rhipiceridae.

The Byrrhidae are treated as on the whole the most central of the families. It is to be understood that the relations between the Byrrhoidea and some of the other series are very close, and that with greater knowledge some of the families will be found to be misplaced.



AFFINITIES OF THE BYRRHOID FAMILIES.

It will be noticed that we have placed *Cupes* and *Omma* in this division as separate families; they show no approximation to the Adephaga, nor are they at all closely allied inter se. Although *Omma* is clearly a "trilobe-form," it is not the simplest condition thereof; the adaptation of the inner sides of the lateral lobes to fit round the median lobe, and the presence of a distinctly enlarged internal sac (although destitute of armature) indicate in fact a fair amount of specialisation.

Cupes clathratus has a highly complex and peculiar organ, which, however, is of the trilobe form. It is also very remarkable by the structure of the last tergite and certain subanal appendages, but the consideration of the

importance of these latter points does not come within the scope of our investigation.

We may also call attention to the fact that a portion of the Colydiidae (as accepted at present) is placed by us among the trilobe forms, while another part is placed in Cucujoidea; we need only add that the heterogeneous family Colydiidae requires a thorough investigation that would probably result in throwing an important light on Coleopterous taxonomy. Other forms placed in the following table near Colydiidae (Derodontidae, Mycetophagidae), should be also investigated with regard to a nearer relation to Trogositidae than is involved by our placing them in different series. Our suggestions as regards these points must be considered merely tentative, in view of the very imperfect state of knowledge on various points.

(2) CUCUJOIDEA.

The families placed under this name are associated by us for the purposes of discussion. Exhibiting considerable diversity inter se, they approximate very closely to the Byrrhoidea, and possibly to the Phytophagoidea. The first of these affinities is chiefly due to Colydiidae, which in its present complex condition we have placed in the Byrrhoidea as well as in the Cucujoidea; the family, as we have previously stated, requires a very extensive investigation, which would probably result in its division. Cucujidae apparently approximates to the Phytophaga by means of *Parandra*, though as regards the male structures we may remark that *Cucujus* appears to be more specialised than *Parandra*. This question is considered in the phylogeny section. Trogositidae is placed in a very central position in this complex. In its normal forms (*Temnochila*, etc.) it approaches the Cucujidae by means of the perplexing *Chaetosoma*. In Cucujidae in the wide sense (for this family will certainly have to undergo division, as has already indeed been insisted on by certain taxonomists), the tegmen forms a less tubular sheath to the median lobe than it does in Trogositidae, while the sac is elongate and placed in repose as in Cerambycidae, and is protected by a strut, very elongate in certain forms and single in Cucujidae, (completely divided in Cerambycidae). As *Chaetosoma* does not display any of these characters it

may, from our point of view, be more correctly placed in Trogositidae. *Thymalus* and *Leperina* depart from the more typical Trogositidae by the lateral lobes being ventrally brought together (completely conjoined in *Thymalus*, incompletely in *Leperina*). This point is of importance, because on account of it we have associated with the Cucujoidea certain families that have been usually associated in Heteromera. The tubular sheath formed by the tegmen in Trogositidae, is found in Cleridae, Byturidae, and in a somewhat different form in Cyathoceridae, and we have therefore placed the families in question in the Cucujid-Trogositid complex.

The curious genus *Diagrypnodes* of Cucujidae will have to be separated from the family; it approaches Pythidae. On the other hand no surprise will be felt at the association of Pythidae and Aegialitidae (which are pretty certainly but one family) with Cucujidae, when it is recollected that the Cucujidae include Heteromorous forms, and that certain genera, e.g. *Rhinomalus* and *Hemipeplus*, have for long been sources of perplexity, as to the distinctions between "Heteromera" and Cucujidae. *Anthicus*, Heteroceridae, Othniidae and *Lathridius* have but little specialisation of the sac; none of them show any special approximation to Cucujidae, but they appear to be less ill-placed in Cucujoidea than elsewhere. *Lathridius* is usually placed in one family with *Corticaria*, but the two have but little connection, and *Corticaria* will perhaps find a better position near Cryptophagidae, though it appears to be very aberrant.

We have no hesitation in placing Coccinellidae in this complex, although Verhoeff (in Arch. Naturges, 61, 1, 1895) has separated Coccinellidae as the equivalent of all other Coleoptera by the nature of the male structures, they possessing, according to his perception, within the "penis" (= our median lobe) a structure he calls the siphon. We do not take the same view of the structures as Verhoeff does. According to our view the siphon is the median lobe (penis of Verhoeff) and the part that hoods it (and that Verhoeff calls penis) is an unusual fold which is certainly a part of the tegmen, though we do not feel called on to decide as to its exact nature without a knowledge of the ontogeny. If this view of the structures be correct, Verhoeff's two divisions of Coleoptera, viz. Siphonophora (= Coccinellidae) and Asiphona (= all other

Coleoptera) is little better than ridiculous. Even if Verhoeff's view as to the outer fold being the median lobe be correct, his taxonomical conclusion cannot be maintained. For in that case the siphon is a secondary development within the median lobe, and secondary developments within the median lobe are frequent, and some of them quite as extraordinary as the Coccinellid siphon. (Cf. Flagellum in various groups, Brentiidae, Cucujidae, Lucanidae, etc.)

Sphindidae and Corylophidae come into the Cucujoidea, and are perhaps least ill-placed somewhere near Phalacridae. Corylophidae is really very different. The forms placed near Endomychidae are very inadequately known, and much more investigation is necessary. Coccinellidae are certainly aberrant, but far from extremely so if such forms as *Lasia* be examined. Certain Heteromorous forms (Oedemeridae, etc.) are placed in this division because of the amalgamation of the lateral lobes on the ventral aspect, a point we have alluded to in connection with *Thymalus* and *Leperina*, but a careful consideration of these forms in connection with those Tenebrionid forms (*Stenosis* and *Zopherosis*) in which the orientation of these parts is similar is desirable.

Cioidae is another form that is not very similar to anything else, but it has the orientation referred to.

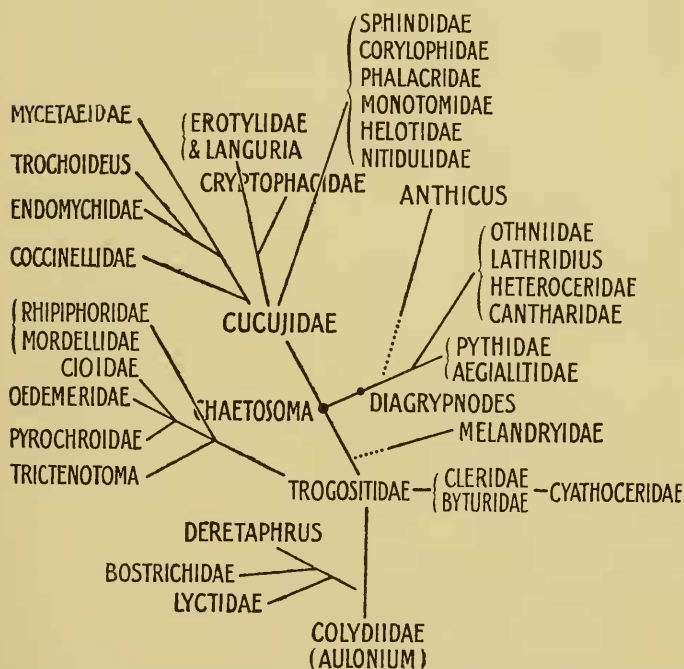
Trictenotominae exhibits a most highly specialised and beautiful structure with the same orientation.

Melandryidae have the more usual (dorsal) orientation. Bostrychidae is most difficult to place; the aberrant *Deretaphrus* apparently really approaches it somewhat.

We must reiterate our opening remark on the Cucujoidea. Many of the families are merely placed in it for purposes of discussion. At present it is our impression that they are really more distantly related than we have made them to appear. But it must be remembered that we have examined but few forms, and that with further investigation connections we scarcely suspect may be forthcoming.

It may be well to elucidate the importance of these remarks by reference to a particular case. Say *Thymalus* (fig. 90). Here the parts identified as lateral lobes are basally conjoined but are apically divided. This form might be derived from an Elaterid (say) form by approximation of the two lobes on the ventral aspect and

a concomitant obliteration of the anterior part of the partition separating them. If we take the view that the forms placed by us at present in Cucujoidea are derived from creatures that formerly possessed definitely distinguished lateral lobes, we must infer a transition more or less similar to the above. If on the other hand we admit that some forms may have originated and developed



AFFINITIES OF THE CUCUJOID FAMILIES

without having come into possession of lateral lobes, we might assign *Thymalus* to such a series; in which case the *ll* of our fig. 90 is merely tegmen, that has to some extent simulated the appearance of conjoined lateral lobes by becoming a little divided and emarginate at the tip. Which of the two theories is the more probable can only be decided by examination of a good series of Trogositidae, and by ascertaining if development throws any light on the subject.

(3) PHYTOPHAGOIDEA (OR RHYNCHOPHORO-PHYTOPHAGOUS DIVISION).

We cannot point to any difference in plan of structure between the Rhynchophora and the Phytophaga. In Chrysomelidae and Curculionidae we find ourselves concerned with series of developments; and the Scolytidae within their comparatively narrow limits also exhibit a similar phenomenon.* Cerambycidae and Brentidae are each so far as we have seen much more homogeneous. Of Anthribidae we have been able to examine but few forms, and these have not led us to suppose that any great diversity will be found within their limits; this family may well be studied in connection with *Belus* in the Curculionidae.

In this enormous complex the tegmen forms, in the more simple kinds, a ring around the median lobe, with a dorsally placed cap-piece, which is usually bilobed; the median lobe assumes the tubular condition in an abbreviated form only, the proximal part consisting of two dorsal struts; the first connecting membrane is large, and allows of a considerable movement of the median lobe within the tegmen; the internal sac is long, and extends through and beyond the median foramen. These conditions are displayed in *Parandra*, and we may remind the reader that they are those of a primitive (and suppositive) Cucujid. It is right to add here that we do not understand the phylogeny of the lateral lobes, because in this division it is specially obscure, and may be multiple, if they are represented at all.

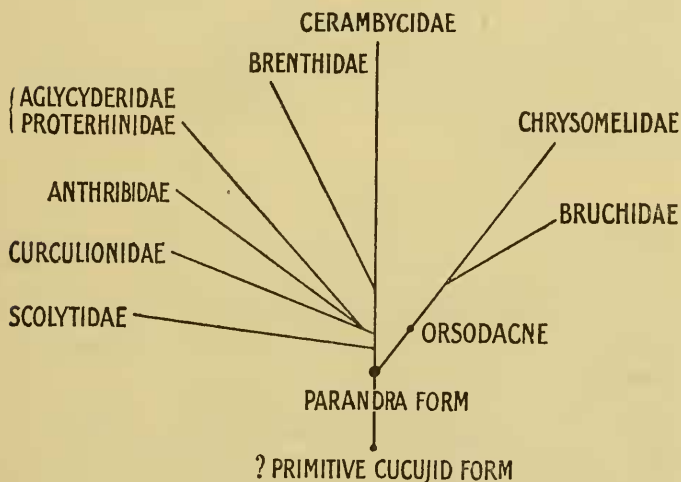
The characters are very persistent in Cerambycidae, and apparently also in Brentidae; most of the specialisations being found in the sac and its armature. *Orsodacne* (usually placed in Chrysomelidae) is interesting, as possessing the simple conditions of the Cerambycid *Parandra*. *Timarcha* has no free lateral lobes but has a large dorsal portion of tegmen, and at the same time two well-developed median struts,—a somewhat anomalous form, therefore.† Specialisation in the Chrysomelidae occurs as

* This is not displayed in our illustrations, but is derived from Lindemann's excellent study of this family, mentioned under Scolytidae.

† Weise (Deutsche ent. Zeitschr. 1895, p. 26) has already called attention to the aberrance of *Orsodacne* from Chrysomelidae. If we

to two chief points; the reduction of the tegmen to a small Y- or V-shaped piece, concomitant with the development of the median lobe into a perfect, rigid tube (cf. *Orina*), enclosing the sac either entirely or to a large extent. The Bruchidae, as at present constituted, are scarcely distinct from the Chrysomelid *Sagra*. In the few Anthribidae we have examined there is no appearance of a division of the dorsal portion of the tegmen.

A development, parallel with that sketched in Chrysomelidae, occurs in Curculionidae and Scolytidae, so far



AFFINITIES OF THE PHYTOPHAGOIDEA.

as the reduction of the tegmen to a Y-piece is concerned. This character is strongly marked in *Platypus*, which may be treated as an extreme form of Scolytidae, though it is not included therein by Lindemann.

Aglycyderidae and Proterhinidae will probably prove not to be separable as distinct families. They are, however, a very interesting form. Though we have placed

rightly apprehend his meaning as to "Penisstütze" in connection with *Timarcha* we cannot in that case adopt his view; two separate median struts not only exist in *Timarcha*, but in *T. geniculata*, at any rate, are highly developed. Examine *Phyllodecta* to see a comparatively rudimentary, or vestigial, condition of the base of the median lobe.

them in this complex they might be placed equally as well with the Cucujoidea. Whichever view be adopted there appears to be no direct connection with any other family, and they can scarcely be viewed as primitive types. They do not approach the Byrrhoidea as there is no appearance of free lateral lobes.

As we have suggested (in speaking of *Parandra*) a connection of this series with Cucujoidea it is only fair to say that a different view may be taken. It might be considered that in this series there are primarily no free lateral lobes, those cases in which they appear to be present in a modified form being merely secondary developments of a single piece. This view would remove the series from any connection, direct or indirect, with the Byrrhoidea. The point is more fully discussed in the section phylogeny.

(4) CARABOIDEA OR ADEPHAGA.

In this type the median lobe is highly developed; the lateral lobes are largely and closely connected with the dorsal margin of the median foramen by means of a prominent condyle; the basal-piece is greatly reduced, or entirely membranous; in the less specialised forms the internal sac is undifferentiated, but in the more highly specialised forms it is large and complex. Pelobiidae, Dytiscidae, Haliplidae are the more generalised forms, and if the Adephagous type is to be connected with any other, these families should be specially studied. As to suggestions for this connection we must frankly say that we have not yet found anything to help us, but their differentiation from the Byrrhoid type is not great.*

It is just possible to consider the series as a modification of the Cucujoid type, the lateral lobes being displaced and fixed in a peculiar manner.

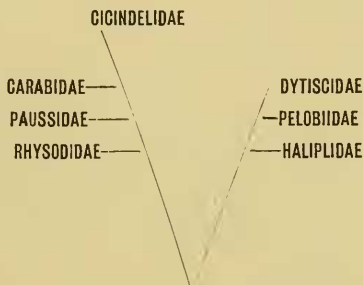
With the reduction of the basal-piece the median lobe becomes more tubular, and the sac more complex. In the Cicindelidae the basal piece is very much reduced, and in the Carabidae it is only represented by a membrane, as stated above.

* We greatly regret that we have not been able to examine the genus *Amphizoa*. The only male of the family that we have seen is the actual type of *A. josephi* Matth., now in the collection of the British Museum.

Taxonomically this is the simplest of all the series of Coleoptera if we limit it as is here done.

The structure of Gyrinidae is on a different plan from that of the Caraboidea. When it is remembered in addition to this that all the members of this family are highly specialised for a mode of life that is shared by no other Coleoptera, we are justified in concluding that this has always been an isolated family.

Cupes and *Omma* do not exhibit any approximation to the Caraboidea of direct nature.



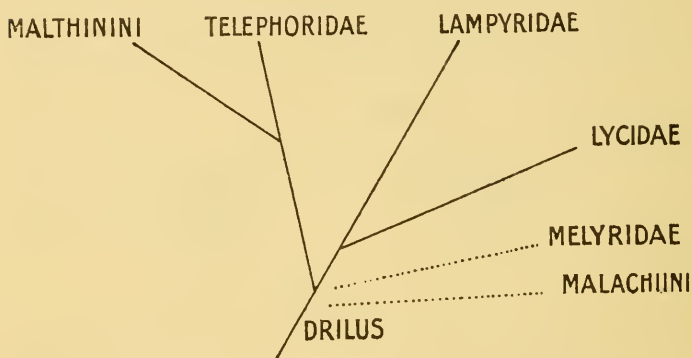
FAMILIES OF CARABOIDEA.

(5) MALACODERMOIDEA.

In considering this complex we may commence by saying that we have rejected from it various families that were formerly included in it. The Dascillidae are, we consider, nearer to the "simple trilobe" forms we have called Byrrhoidea. The Cyphonidae we are obliged to omit as their aedeagus appears to be very peculiar, and we do not yet understand it.

This still leaves numerous forms as Malacoderms. As regards some of them taxonomists are not by any means agreed as to their family rank. We take *Drilus* as one of the simpler forms. This is a trilobed form modified as to the articulations between the median lobe and the lateral lobes, and between these and the basal-piece. The similarity between this and the more modified Lampyridae is evident. The Lycidae in their simpler forms (*Dictyopterus aurora*) also approach *Drilus*, and in more differentiated forms (*Lycostomus*, etc.) still have the same arrangement, though the median lobe may become

elongate (to a remarkable extent), and the lateral lobes diminished. The Telephoridae (*Rhag. limbata*) exhibit a remarkable specialisation in the very bulbous form of the median lobe, but the New Guinea *Chauliognathus*? (fig.139) is much less remarkable, and departs to a comparatively slight extent from *Lampyrus*. *Malthinus* and *Malthodes* appear to be modifications of the Telephorid plan.



AFFINITIES OF SOME OF THE MALACODERMID FAMILIES

As regards "Melyridae" we fail to connect them satisfactorily with the Malacoderms, but as we cannot assign them any other place in a system we treat them here. In addition to this we may remark that the family will very likely have to be sundered in two or more. *Malachius*, however, may prove to be a form annectant to the highly specialised *Astylus* (Melyridae proper) and the aberrant *Balanophorus*. As regards the sac, the lower forms of the Malacoderms have it but little specialised, but in higher forms (those allied to *Telephorus* and the higher kinds of Lycidae) this structure becomes complex, as it is in all the Melyridae we have examined. *Phloeophilus* cannot be admitted to either the Malacoderms or the Melyrids till annectant forms are brought to light.

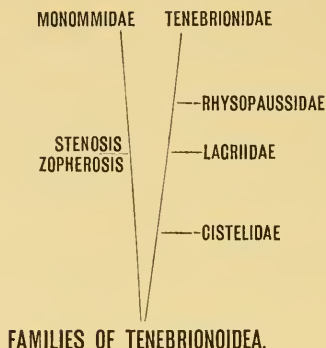
(6) TENEBRIONOIDEA.

Under this name we can associate at present only a few families, because we are of the opinion that several

of the families combined with Tenebrionidae to form the "Heteromera" must be separated. The comparatively small families, Cistelidae (Alleculidae of many recent writers), Lagriidae and Rhysopaussidae, are really allied to the huge group Tenebrionidae. Of this latter complex it will be noticed that we have examined but few forms. Taking *Pediris* as a central one we find the tegmen consisting of an elongate tubular basal-piece, chitinous on the dorsal aspect, with well marked and separate lateral lobes, making lateral and dorsal protection of the elongate median lobe. In the more specialised Tenebrionidae (e.g. *Eleodes* and *Blaps*) the lateral lobes are soldered together, and the median lobe is reduced in extent. In certain cases (*Cossyphus*) the median lobe is reduced to a nearly or quite membranous condition, and in Cistelidae and Lagriidae there is a similar reduction. In the type of the Nosoderma-group we have examined (*Zopherosis*) there exists a distinction from *Pediris* that we must treat as of considerable importance, inasmuch as the chitinisation of the tegmen occurs on the ventral aspect, the lateral lobes being united in that position. This suggests that a complete sundering of the Tenebrionidae will be found necessary. *Stenosis* agrees with *Zopherosis* in this respect. It would be well worth examining *Adelostoma* and allies to ascertain whether there is a real affinity between the *Stenosis* and *Zopherosis* forms, but we have not been able to carry our investigations of the Tenebrionid forms farther than the inadequate extent that will be found in our anatomical section.

As regards the families of "Heteromera" other than those mentioned above, we have already said that we have failed at present to connect them with the Tenebrionidae; and we have assigned them tentatively positions in the Cucujoidea. Whether the Tenebrionidae really link on as further differentiations thereof (cf. Melandryidae and Pythidae) we are not prepared to express an opinion. We have left Monommidae in the Tenebrionid division (along with the *Stenosis-Zopherosis* forms), but it appears to be really very isolated.

We may conclude our brief remarks on the Tenebrionidae alliance by referring the reader to what we have said elsewhere as to the "simple trilobed form of aedeagus," and adding that there is not here a great departure therefrom.



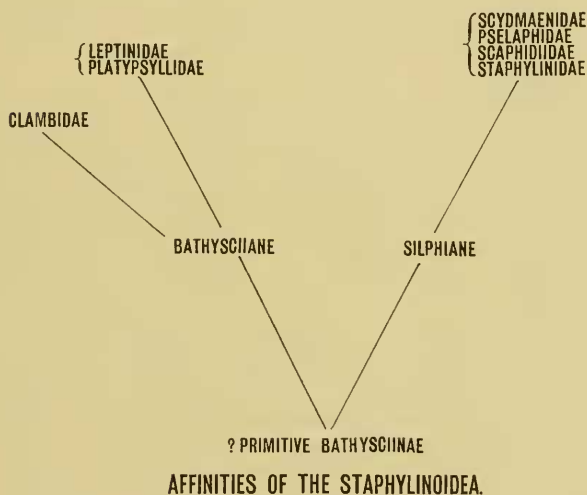
(7) STAPHYLINOIDEA, OR BRACHELYTRA.

In this division the family Staphylinidae is of the first importance, because of the great number and diversity of its forms. This family is characterised by the existence of a highly developed median lobe, by the absence of a basal sclerite, the lateral lobes being diversified in form. In the *Xantholinus* group we are in presence of one of the most highly specialised forms of Coleoptera. In the Omaliini we find an approximation to Silphidae. The Silphidae are in fact the most primitive of the families placed in this division.

The Silphidae proper differ much from the other forms of the family we have examined. In *Bathyscia* and *Liodes* (= *Anisotoma humeralis* of the European catalogue) there is a very large median foramen, basally placed, and a median lobe elongate and tubular in form; there is a basal-piece separated from the median lobe, and well marked lateral lobes closely connected with the basal-piece, and thus forming a well marked tegmen. But in Silphidae (*S. obscura*) the median lobe is bulbous, rather than tubular, with a small median foramen (often placed distally), a small basal-piece, with well marked lateral lobes forming thus a complete tegmen. This supports the division of Silphidae into two families.

The Silphinae show relationship with Staphylinidae; but if we consider Bathysciinae as more primitive than Silphinae, then the affinity of Staphylinidae with Silphidae s.l. is of an indirect nature. If, however, we consider (as is frequently done) Bathysciinae and Silphinae

as one family (= Silphidae s.l.) then this is more primitive than Staphylinidae, and we may distinguish the two by the presence of a basal sclerite in Silphidae which is absent in Staphylinidae. Of the other families included in the Brachelytra, Leptinidae and Platypsyllidae approximate the Bathysciinae division of the Silphidae, while Pselaphidae, Scydmaenidae and Scaphidiidae approach Staphylinidae. Clambidae is highly specialised, but appears nearest to the Bathysciinae; it is, therefore, a family long separated from the most primitive form of the Brachelytra.



(8) SCARABAEOIDEA, OR LAMELLICORNIA.

It is generally considered that this is one of the most distinct of the great divisions of the Coleoptera, and our investigations quite confirm this idea. At the same time much difference of opinion exists as to the families and their relations inter se, some naturalists considering Lucanidae and Scarabaeidae as incapable of distinction, while others maintain that they have but little affinity.* Probably the solution of the difficulty will be found by increasing the number of recognised families. Usually

* See Escherich, Wien. ent. Zeit. xii, 1893, p. 265.

these are three, viz. Passalidae, Lucanidae, Scarabaeidae. We will return to this point after touching on the peculiarities of the group.

The first of these is that in the enormous majority of the forms there is a great reduction of the scleritic parts of the median lobe. If the characters of a Lucanid and a Scarabaeid be examined, it would at first be supposed that but little real affinity exists between the two. On the other hand, if *Trox* (usually placed in Scarabaeidae) be added to the compared material, the difficulty becomes that of separating the two divisions, for *Trox* agrees better with Lucanidae than it does with Scarabaeidae. *Trox* is not only very important in this respect, but also because it throws some light on the very peculiar male structures of the Passalidae.

The Scarabaeidae, while exhibiting a reduction of the scleritic parts of the median lobe, display an enormous development of the basal-piece, which forms the "tambour" (Straus-Durckheim) of the organ. This tambour usually shows a constriction which might at first sight be supposed to separate it into two parts, in which case the proximal part only would be taken as the basal-piece, and the distal portion might be supposed to be part of the median lobe. This, however, is a most superficial observation; the constriction in question merely marks the attachment of the connecting membrane, the two portions of the tambour being one enormous basal-piece. The lateral lobes are most remarkable and are very diverse. They form what is usually, in this division, called the forceps. In some cases they are separate, not amalgamated, at their bases (*Spilota*, etc.); in another condition they are amalgamated on the dorsal aspect, forming an undivided piece (*Pelidnota*); while a third condition exists in *Lomaptera* (Cetoniinae), where the amalgamation of the lobes occurs on the ventral aspect. In *Ischiopsopha* by a modification of this they form a complete scleritic ring, as they do in *Xylotrupes*. The ventral surface of the basal-piece is usually membranous for a large area, but in some forms there is a chitinisation of this surface, to which we have applied a special name, the ventral-piece (fig. 19, *vp*). In some cases this ventral-piece becomes quite chitinously continuous with the lateral lobes (*Xylotrupes* e.g.), forming thus a very large irregularly shaped sclerite.

The sac in Scarabaeidae is usually largely developed in size, and also in form, showing lobes, or numerous diverticula (*Hexodon*), or even large peculiar sclerites (*Spilota regina*, Newm.).

(We have already alluded to the reduction of the median lobe in Scarabaeidae, but may here say that in our anatomical section we point out that no line of sharp demarcation can be drawn between median lobe and sac. The reduction of the median lobe in Scarabaeidae, compensated for—so to speak—by the remarkable developments of the sac is a matter worthy of special investigation.)

After these remarks on the Scarabaeidae, if we turn to the Lucanidae, we again find remarkable diversities, but of a totally different kind. The median lobe is well developed. In some cases there is a conspicuous fine terminal tube called the flagellum; this specialisation is more correctly described as a part of the sac. The sac in Lucanidae frequently is not invaginated, but is crumpled up, and the "flagellum" is merely a prolongation of that one of its lobes (or parts) on which the orifice of the duct is situated. The flagellum is clearly not of great morphological importance.

The basal piece in Lucanidae is very varied as regards size, being sometimes quite small (*Ceratognathus*), in other cases (*Neolamprina*) large and tubular, but we have not found any case in which it really approximates in shape to the "tambour" of the Scarabaeidae.

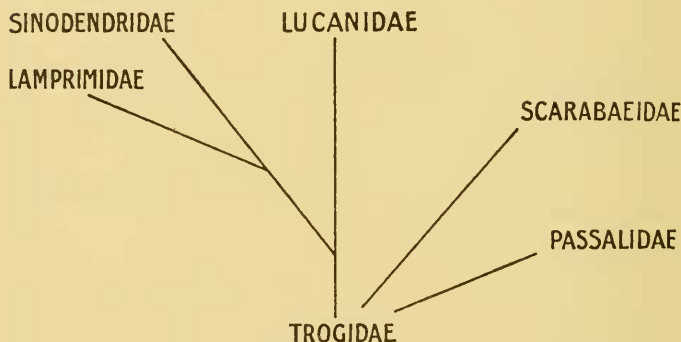
The lateral lobes of the Lucanidae are always well developed (though very slender in *Aesalus*), and they are never conjoined (we have pointed out that they are conjoined in three different ways in Scarabaeidae).

The genus *Trox* (s.l.) is usually placed in Scarabaeidae. In the recent Catalogue of European Coleoptera it immediately follows the Lucanidae. So far as regards the male structures it is impossible to look on *Trox* as a Scarabaeid. It might, on the ground of these structures, be placed in the Lucanidae, but if other considerations demand its separation therefrom, it must form a separate family, equivalent in import to each of the two families mentioned. The relation of *Cloeotus* and *Anaides* with *Trox* requires a careful examination.

This family Trogidae is of the first importance. It seems to offer the only inkling of a connection of the

highly peculiar Passalidae with the other divisions of Scarabaeidae.

In the Passalidae the median lobe is large and globular, membranous around the median orifice, which is large; small median struts are sometimes attached to its base. The lateral lobes are consolidated, have not the character of lobes, but form a plate. The basal-piece is distinct, except in *Aulacocyclus* (fig. 13), where it is lost or entirely consolidated to the lateral lobes. The internal sac is large. All these characters are approached in *Trox omacanthus*, but in neither Lucanidae nor in Scarabaeidae do we find any suggestion of a direct connection with Passalidae.



AFFINITIES OF THE SCARABAEIOID FAMILIES

The great importance of the Trogidae in this division is evident, but becomes singularly significant when we realise that it also approximates greatly to the Byrrhoidea series.

In concluding our scattered remarks as to the Scarabaeoidea we may say that we think that the taxonomy of this division is still very imperfect. We greatly regret that we have not been able to examine some of its most enigmatic forms (e.g. *Nicagus*),* but we feel that it would

* Thanks to Mr. E. A. Schwarz, F. Muir has since been able to examine the long disputed *Nicagus*. It has a well defined median lobe, with median orifice on dorsal aspect of tip; well defined lateral lobes a little longer than the median lobe, broad at the base and gradually tapering to a pointed tip, the bases meeting on the ventral

even in that case have been highly improbable that we could have contributed much to the elucidation of the enormous complex. This would be of itself a considerable work.

PHYLOGENY.

In considerations as to phylogeny, palaeontology should be of the first importance. Unfortunately our knowledge as to this subject is dreadfully incomplete and is we fear likely to remain so for a very long period. In fact all we know is that no Coleoptera have yet been found earlier than the Triassic period; and that long anterior to that there existed many insects some of which it is reasonable to suppose were precoleopterous ancestors of the Order. Handlirsch suggests Blattoid or Sialoid ancestors. Only 18 of these ancestral Coleoptera are known in the Trias, and the whole of the subsequent mesozoic period only shows a total of 352 species. No information whatever exists as to the structure of the male genital tube of the fossil forms, so that palaeontology is of no assistance in our present special inquiry. All we can say is that with Handlirsch's plate 41 before us, in which the remains of the Liassic Coleoptera are figured, we may say that a considerable number of the forms are such as we should expect to find provided with a simple trilobe aedeagus or a Caraboid one. While in plate 39 fig. 4 we are inclined to consider *Pseudelateropsis* Handl. as a relative of *Cupes* or *Omma*. The condition of these fossil Coleoptera is, however, such that we really learn but little from them beyond the existence of a number of very distinct forms among the earliest Coleoptera.

In the absence of palaeontological guidance students of Coleopterous phylogeny have been driven to rely on other characters. The male genital tube has received no consideration in this respect, but we believe that it will be recognised as of great importance as elucidating phylogeny especially when it shall have been studied in conjunction with the female structures. There are in fact three main lines of inquiry as indicative of relationship, (1) the body and its appendages, (2) the genital conduit (*i.e.* the structure of the combined male and female parts), and

aspect but not on the dorsal; basal-piece well developed and chitinous on the ventral side; internal sac small and very little differentiated. This type is similar to *Trox* and some of the less specialised Lucanids.

(3) the ontogeny. To which may fall to be added as a fourth, the structure of the sexual glands.

We had at first decided not to write a phylogenetic section for our memoir, as our knowledge is so imperfect and is liable to correction in so many ways. Yet recalling the fact that the other departments are also but imperfectly known, so that there is but little agreement amongst phylogenists, we have concluded that a section on phylogeny of the genital tube, though somewhat premature, may be welcome nevertheless. It will at any rate exhibit the difficulties and complexity of the subject.

Our inquiry has led us to suggest the arrangement of Coleoptera in eight series. Remarks on these series appear in the section taxonomy. A connected account of their apparent relations, and an account of some of our reasons for the conclusions we have come to follow this, and the most important points will be found discussed under *Phytophagoidea* and *Byrrhoidea*.

1. *Byrrhoidea*.—The aedeagus appears to us to be in this series in its simplest condition, and at the same time to be the form most capable of modification to result in the structures we meet with in other groups, as we have already mentioned. The series itself is, however, far from being homogeneous and we shall not be surprised if some of its forms prove to be really separate series. *Cupes* and *Omma* may be mentioned. Also *Gyrinidae*. *Atractocerus* requires serious attention, and it may be doubted whether *Buprestidae* are really in phylogenetic accord with other *Byrrhoidea*.

We have frequently stated that we consider the trilobe form of aedeagus as it is exhibited by the *Byrrhoidea* to be the simplest, and probably the more primitive, of the existing forms. Our reasons for this are (1) that "low" forms of various divisions are found to possess the genital tube in a state but little different from the trilobe of the *Byrrhoidea*. (2) That in highly specialised groups of which there exist a sufficient variety of forms we have always been able to find in certain cases one or more points that form an apparent transition to the trilobe. This of course may be illusory (as indeed we shall argue when discussing under *Phytophagoidea* the questions connected with "lateral lobes"), but it shows that the modification of the trilobe is to the imagination easy, and

we all know that in the absence of direct evidence phylogenists have only too frequently to resort to the use of the imagination. (3) The internal sac is found in its simplest condition among the trilobe forms, and attains its highest development amongst forms in which the aedeagus is very different from the simple trilobe. (4) In various females that we have examined the structures depart but little from the trilobe form. Thus in *Rhizophagus depressus* the female tube consists of a large basal piece with strong lateral lobes (*i.e.* there is a tegmen of the trilobe form). The median lobe is rather small, and its chitinisations are less compacted and coadapted than in the male aedeagus, the duct opens at the apex, and there are basal struts. In this species the male (fig. 101) departs considerably from the trilobe form.

2. *Caraboidea*.—This division, as limited by us, is remarkably homogeneous, and forms as regards the aedeagus one of the most satisfactory series of the Order. We have suggested that it might possibly be derived from Byrrhoidea. This would be accomplished by dragging the lateral lobes away from one aspect of the median lobe, and connecting them with a condyle on the other aspect. The basal-piece must become membranous (it is imperfectly chitinised in Cicindelidae), and completely ride over, or cloak the base of the median lobe. The last character being of a Cucujoid nature. We have no belief in such changes having occurred during the Coleopterous stage of the phylogeny.

3. *Cucujoidea*.—This is an assembly of many families, and will probably require much emendation and even division. The main points of distinction from Byrrhoidea are that the tegmen rides over the median lobe, and that the lateral lobes are differently placed. The question of deriving the series from Byrrhoid ancestors is discussed in our considerations as to series 8, Phytophagoidea.

4. *Staphylinoidea*.—In the higher forms this is a most distinct division, the aedeagus appearing to function by means of an aneurism of its basal part. We have associated Silphidae with Staphylinoidea because in the lower forms of the great family Staphylinidae (Omaliini and Piestini) the peculiar structure is much less perfect, so that we think it possible the Silphoid forms and the Staphylinoid forms may prove to be not separable by the male genital tube. The lateral lobes are extremely varied

in Staphylinidae, and assume different functions in the various divisions. The question of a relationship of the series with Byrrhoidea cannot be properly considered in the absence of a decision as to the relations of Staphylinidae and Silphidae, alluded to above.

5. *Malacodermoides*.—Though the simpler forms of this series approach the Byrrhoid structure, yet we have not found any form that really connects the two. In the low Malacoderms the median lobe is insignificant in size compared with the lateral lobes, but the large development of the latter is on the basal parts, and the great distal development of these parts as found in Byrrhoidea does not occur in the Malacoderm forms we have examined, so that the relations of the parts appear to be different. In higher Malacodermidae the median lobe may be greatly developed, and the parts become so complex that a careful analysis is requisite for their comprehension. Under these circumstances we are not prepared to say more than that we shall not be surprised if a more thorough investigation should reveal annectants to the Byrrhoidea. As regards the Melyridae we have remarked in the taxonomical section that it presents special difficulties.

6. *Tenebrionoidea*.—As regards this series we have said in taxonomy the little that we are prepared to advance as to the phylogeny of the series. The difficulties arising from the orientation of some of the forms, alluded to under Taxonomy, is considerable. When lateral lobes, or when tegmen, are ventrally placed, are we justified in considering them homologous as regards origin with similar structures dorsally placed? The answer to such a question if it concerned the chroötic tube would certainly be a negative one; but as regards the genital tube a positive answer cannot be given till the remarkable cases of torsion and distortion that occur have received a more thorough consideration.

7. *Scarabaeoidea*.—This is a very distinct series, except that by means of Trogidae and certain Lucanidae it approaches the Byrrhoidea, to which therefore it may be linked. The Lucanidae appears to be a group of fragments, and, small as it is, offers a remarkable contrast to the huge family Scarabaeidae.

8. *Phytophagoidea*.—Under this series we have united all the great divisions of Rhynchophora as well as the Chrysomelidae and the Cerambycidae or Longicorns. We

have not found between Rhynchophora and Phytophaga any distinction that is valid throughout the two divisions, though it is not improbable that an extended study would reveal some important difference. At present the Phytophagoidea is by far the largest of the eight series.

The question as to the distinctness of the series depends largely on the view that is taken as regards "lateral lobes" in Coleoptera. To explain the view we are inclined to take, a digression of some length is necessary.

It has been suggested that lateral lobes may be modified appendages of the body. We have not found anything to support this view. Indeed if it were so they were doubtless modified in the precoleopterous stage of evolution and the point would therefore only indirectly concern us. But we incline to another view on this highly speculative point. We suggest that Coleoptera are descended from ancestors in which the efferent ducts from the sexual glands, either as a pair or singly, opened on a membrane connecting the 9th and 10th ventral plates of the abdomen, while the orifice of the alimentary canal was placed immediately above the 10th sternite, which thus separated the two great exits. By slight elongation of the membrane of orifice of the efferent ducts, they were in repose withdrawn within the body cavity; and a somewhat analogous phenomenon occurring with regard to the rectum, the genital tube and the apex of the rectum became, in the imago, placed inside the body cavity. The 10th sternite (between the two parts) shared their invagination so that the external body wall was terminated behind by the apposition of the hind margins of the 9th abdominal sternite with the 10th, or some other, tergite. This apposition, with of course considerable and in some cases very great modifications, has attained so great perfection that sometimes it is very difficult to see any opening at the posterior extremity of the body. According to this view the genital tube is merely an elongation of a connecting membrane between two ventral plates; the modified 10th sternite either entering into the composition of the tube or not, as the case may be. It may be well here to remark that for the purpose we have now in view, we are mentioning only the simplest aspect of the matter. For our purposes it does not signify how many abdominal segments there were originally, or whether more than one were indrawn either subsequently

or concomitantly with the changes as to the invaginated genital tube.

The complete invagination of the male structure in the enormous majority of forms is a marked feature of Coleopterous anatomy. Another trait of the Order is the extraordinary extent to which chitinisation is carried. The external parts of Coleoptera are in some cases harder than bone, and in these cases the internal phragmas and apodemes may share in the hardness, as also the male genital tube. For instances we may mention the chitinisation of this structure in the Histeroid genus *Oxysternus*, and the Buprestoid *Euchroma*. A further development of the genital tube is exhibited by elongation, and by chitinisation. We have just mentioned examples of its perfect hardness, and as specimens of its elongation may mention the long flagella so frequently met with, and the remarkable elongation of the sac (or stenazygos) in *Eumolpus*, where it is about $1\frac{1}{2}$ inches long. Turning now to the question of the origin of the sclerites of the tube, we know from the structure of the body wall that exposed large surfaces become very strongly chitinised while immediately contiguous parts remain delicate membrane. The chitinisation takes place by the intermediary of hypodermal cells, and it may well be that the reason for parts remaining membranous is due to creases preventing the proper development of hypodermal cells there, and, possibly, their extension in certain directions.

As the genital tube became elongated it would in the invaginated condition be crumpled and creased, and the formation of separated sclerites on it may probably have been to some extent determined by the nature of these foldings.

We make these suggestions with a view to getting the student to realise the probability that the development of the genital tube is due to factors that are on the whole similar to those that have determined the structures of other parts of the body. The factors are not really known. The phenomena of chitinisation are indeed specially obscure, and we are not aware that any one has offered an explanation of the fact that Histers are hard and Malacoderms soft. Neither do we pretend that there is a perfect co-relation between the chitinisation of the sclerites of the body wall and those of the genital tube: in fact we are well aware that in some cases the opposite is true.

We will now turn to the point for the elucidation of which this digression has been made, viz. the value of lateral lobes in the consideration of phylogenetic points.

The lateral lobes extend in the longitudinal direction, while the various invaginations are the result of transverse creasings. That lateral lobes can be much modified in their position is clear. There is no doubt that they can be brought more to the ventral surface or more to the dorsal surface, and there is no doubt that they can be approximated, made contiguous or even conjoined. These facile changes, whether great or small morphologically, have no doubt been actually limited, and when we recollect that there must always have been such an agreement between the male and the female parts of the genital conduit that good viability was invariably preserved, we must adopt the view that may be summed up in the words, "the less change the better."

Are lateral lobes present in all Coleoptera? And if they are not to be definitely seen in some forms is this to be attributed to original absence or to secondary modification?

In the Byrrhoidea lateral lobes are a conspicuous feature. So are they also in Caraboidea, with a slight difference in position. They are present in the Staphylinidea in a variety of shapes and modifications of a very interesting character. They also exist in Malacodermodea, in Tenebrionidea and in the Scarabaeoidea.

In the Cucujoidea lateral lobes appear to be absent. But there are frequently present apically and on the middle of the tegmen two articulated processes that may be considered to be their homologues by process of a change to explain which we must make another brief digression.

If the reader will examine one of the typical Byrrhoidea, *e. g.* a large Elaterid, he will note that the tegmen is so attached to the median lobe as to permit of little or no independent movement of the two; they work, in fact, as a single layer. Let him then take a Cerambycid aedeagus (the members of which are all conformable as regards the point in question), and he will find the reverse condition displayed, the median lobe and tegmen being so arranged as to permit of a play of the former through the latter, the two parts function as two layers, one cloaking the other.

Returning then to the Elaterid he will notice that the change required to permit the tegmen in that form to ride over, or cloak, the median lobe consists in the first place of an elongation of the connecting membrane between them. If this take place and the liberated lateral lobes be approximated dorsally, we have in fact the essentials of the arrangement as we find it in Cucujoidea. We might, then, conclude that it is permissible to derive the Cucujoidea from the Byrrhoidea. When, however, we turn to consider whether such a change has ever actually occurred, we must ask ourselves whether it is probable that an aedeagus that is functioning as an organ of one layer would change into a structure that functions as a two layer arrangement. We think the answer would be that in the early conditions of the genital tube such a change might occur, but that after the aedeagus had attained a considerable development nothing of the sort is at all probable.

We now return to the consideration of the Phytophagoidea. If a well-developed Cerambycid aedeagus (say one of Clytini) be compared with *Cucujus* it will be noticed that in the position occupied by the "lateral lobes" (if really such) of the latter there is in the *Clytus* a divided, or rather cleft, process resembling the *Cucujus* lobes, and it would appear therefore that if the *Cucujus* possesses lateral lobes so also may the *Clytus*.

A further examination of a variety of forms of the two series produces the gravest doubts. In the Cucujoidea the lateral lobes are either articulated at the apex of the tegmen, or if the articulation be absent, the single part has the appearance of being two parts combined (cf. *Helota*). But in Phytophagoidea (at any rate in Cerambycidae) there is never any articulation of the apical processes of the tegmen, and the comparison of a series of forms suggests that the bilobed state of the apex of the tegmen (or cap-piece) may be the result of progressive emargination of what was originally a single piece.* In that case the

* In the Cerambycidae (especially marked in genus *Phrissoma*), there is a ridge on the underface of the divided cap-piece giving an illusory appearance of articulation of the two lobes. In the Curculionidae the appearance is different: there are often two separated lobes (the "papilla" of Hopkins in *Pissodes*), and in *Eupholus* the lobes are widely separated (this point is not well shown in our fig. 222a), while in some other Rhynchophora there is a single median prolongation of the cap-piece. None of these cases is similar

Phytophagoidea have no lateral lobes and are different from the other great groups. It is then only possible to derive them from some primitive Cucujoid form unknown to us. The term primitive (suppositive), as here used, may probably be interpreted as implying that if a connection of Phytophagoidea with our other series ever existed it was in the precoleopterous phylogeny. Though we have not discovered any important distinction between Rhynchophora and Phytophaga as regards the aedeagus, we may point out that our investigation of these two enormous complexes is very far from exhaustive as to this point. Also that this memoir is not concerned with other distinctions.

We consider that the genital tube of the male is of great importance in the phylogeny of Coleoptera. And that its study makes it extremely difficult to accept less than eight primary divisions of the Order.

VI. ALPHABETICAL INDEX OF FAMILIES AND SERIES

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to what we have found in the Cerambycidae. It is therefore possible that even the aedeagus may ultimately show the Rhynchophora to have an origin distinct from the Cerambycidae.

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EXPLANATION OF FIGURES.

The figures are all original, and have been drawn with the aid of a camera lucida from our own dissections. The scale of magnifica-

tion is varied. Although this point is not of great importance for our purposes, the scale is in most cases indicated by a line placed near the figure. When no number accompanies the line then the length of the line is 1 mm. and the magnification of the figure is indicated by that of the line. When a number accompanies the line, the number indicates the length of the line in millimetres or a fraction of one.

The connecting membranes between certain parts are only partially shown in the figures. To have invariably introduced them would have involved the use of shading; and much artistic ability would even then be required to distinguish the scleritic from the membranous parts. The student will recollect that these membranes always exist connecting the median lobe to the tegmen, and the tegmen to the body wall. Sometimes a part of one of the membranes is shown, and it is then indicated as such by the torn edge.

The position shown is very frequently not a true profile, but a partial one, thus allowing more of the parts to be seen and inferred. The drawings have all been made from specimens in a wet, or relaxed, state; and the student must not expect to find exactly the same appearances in dried and collapsed preparations.

The figures are as a rule uniform as regards their longitudinal position, the distal end being to the right so that a side-view shows the left side. In a few cases, in order to show certain structures, the right (not the left) side is figured; and in that case in order to make comparison more easy the figure is orientated so as to make the right side look as if it were the left one, and it is stated to be "reversed."

Broken lines indicate parts that are lying below the structures represented by unbroken lines. They are introduced to show the continuity of portions that are not actually seen in such a dissection as that figured. Where these concealed parts are the sac and the duct the broken lines are reduced to dots.

We use both single and double letters to indicate special parts. The double letters are used uniformly throughout the figures, and are explained below this, and more fully on pp. 481-483. The meaning of a single letter will be found by reference to that descriptive portion of the memoir to which the figure pertains.

EXPLANATION OF DOUBLE LETTERS.

aed = aedeagus.

an = anus.

bp = basal-piece.

cm 1 = first connecting membrane.

- cm* 2 = second connecting membrane.
ej = ejaculatory duct.
fg = flagellum.
is = internal sac.
ld = last dorsal plate.
ll = lateral lobes.
lv = last ventral plate.
mf = median foramen.
ml = median lobe.
mo = median orifice.
ms = median strut.
pa = point of articulation.
pd = penultimate dorsal plate.
pv = penultimate ventral plate.
rt = rectum.
sp = spiculum.
tg = tegmen (lateral lobes + basal-piece ; or basal-piece
without lateral lobes.
ts = tegminal strut.
vp = ventral-piece.

For a fuller explanation of these letters see pp. 481-483.

Correction.

P. 491. If the position of Fig. 39 (*Haliphus*) be considered correct as regards upper and lower aspects, then it is the right lateral lobe. That is the broad one, not the left as stated in the text.

DEC. 24, 1912.